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THE BULLETIN OF THE ATOMIC SCIENTISTS

The *Bulletin* was founded in 1945 by Eugene Rabinowitch and Hyman Goldsmith.
The *Bulletin* clock, symbol of the threat of global catastrophe, stands at 17 minutes to midnight.

ARTICLES

Nuclear temptations

When the Nuclear Non-Proliferation Treaty
was signed 25 years ago, many worried that nuclear weapons
could become the common currency of regional power conflicts.
It hasn't happened—yet.
But today, Pakistan has proved
that even a poor country can build a bomb;
North Korea has renounced the treaty in a huff;
and Russian warheads could migrate—for a price.

A proliferation primer
DAVID ALBRIGHT
14

Russia's "red-brown" hawks
VITALII I. GOLDANSKII
24

Europe's leaky borders
HARALD MÜLLER
27

Europe's nuclear dominos
JANE SHARP
29

Asian ambitions, rising tensions
RYUKICHI IMAI
33

An equal-opportunity NPT
K. SUBRAMANYAM
37

A sacred matter
AVNER COHEN
39

Myth-making: The "Islamic" bomb
PERVEZ HOODBHOY
42

With cartoons by FRANK COTHAM

Cover illustration by Frank Cotham.

THE FRONT PAGES

Editor's note
2
Eating grass

Bulletins
3
Defense budget, ACDA, more

Reports
8
South Africa's nuclear plans
DAVID ALBRIGHT

Perceptions of Chernobyl
GLENYS A. BABCOCK

Russian dumping
SERGEI LESKOV

THE BACK PAGES

Reviews
50
American Ground Zero
by Carole Gallagher
IRIS POLISKI

Genius in the Shadows
by William Lanouette
with Bela Silard
REBECCA LOWEN

Between Fear & Hope
edited by Sonia Shah
STEVE BREYMAN

War in the Age
of Intelligent Machines
by Manuel DeLanda
JOHN BELL

Nuclear notebook
56

This One
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EDITOR'S NOTE

Eating grass

Zulfikar Ali Bhutto, Pakistan's young and ambitious foreign minister, had a lot to brood about in 1965. His nation had gone to war with India over Kashmir. Although the war had been short, it lasted long enough to make it obvious that India had become a major act in the international three-ring circus—a nation simultaneously able to fight Pakistan, play off the Soviet Union and the United States against one another, and even challenge China from time to time, at least peripherally.

India was larger, richer, and militarily stronger than Pakistan, and it seemed likely that it would develop nuclear weapons, making it king of the mountain on the subcontinent. Bhutto was not willing to let that happen. "If India builds the bomb," he is reported to have said in 1965, "we will eat grass or leaves, even go hungry, but we will get one of our own."

India eventually got its bomb. And Bhutto—by then, Pakistan's prime minister—wasted no time in getting Pakistan's bomb program under way. Call it the Charles Atlas Factor. If you want to be a player, you need nuclear weapons. Without them, your enemies will always feel free to kick sand into your eyes.

Well, maybe Charles Atlas got it wrong. Since 1945, nuclear weapons have been perceived by many world leaders as conferring upon their owners prestige, security, and foreign policy muscle. But as we watch the unraveling of the former Soviet Union, it's reasonable to conclude that, in the end, nuclear weapons had been of little use to Moscow. The Soviet Union managed to kick sand in its own face.

A strong, just, and economically viable society is not built by insisting that people eat grass, even metaphorically. Moral issues aside, nuclear weapons have had little real-world utility over the years. They have not been good investments. The leaders of Russia and the United States seem to realize that now, however dimly. We hope that that notion also gets through to the Bhuttos and Husseins of the world.

Last December, the American Academy of Arts and Sciences and the Albert Einstein Peace Prize Foundation convened a symposium at the University of Chicago to examine the proliferation of nuclear weapons. Now that the East-West nuclear arms race is a fading memory, conferences on proliferation are a cottage industry. I don't say that to knock such meetings. Proliferation is a serious matter, one that may quickly grow worse if the former Soviet Union's nuclear priesthood ever loses control of its fissile materials.

Nevertheless, the sky is not falling, and one of the impressive features of the Chicago conference was that no one suggested that it was. In this issue we present a sampler from that conference. I emphasize "sampler." We had to pick and choose portions of only a few papers, and we had to leave certain terrific papers out altogether, because for one reason or another, they just didn't "fit." (And... many thanks to the papers' authors as well as to the Einstein Foundation and the Midwest Center of the American Academy for graciously giving us permission to use portions of the papers.)

Finally, please note that the Nuclear Non-Proliferation Treaty was signed 25 years ago July 1. That treaty embodied two grand ideas—it would prevent the spread of nuclear weapons to "have-not" nations, while insuring that the "have" nations would cut back their arsenals. The document also incorporated a distinctive and practical idea—a kind of sunset provision. The treaty, which entered into force in 1970, stipulated that a conference would be held after 25 years, at which time the long-range fate of the treaty would be hashed out. Has the treaty worked? As we approach the 1995 review conference, be assured that the *Bulletin* will examine that question. Stay tuned.

—Mike Moore

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BOB SCHOCHET

Treading water

Defense Secretary Les Aspin is the most engaging of people. Voluble, frank, and witty, he is not like many pompous politicians who speak as if every word were of the utmost gravity. He is a free-flowing thinker, and often a free-flowing talker. In his new role as one of the highest officials in the land, his volubility may get him into hot water.

At the end of March, Aspin unveiled the details of his budget proposals for fiscal year 1994, which begins October 1, 1993. While his press release trumpeted the document as "the first truly post–Cold War budget," his spontaneous remarks were more revealing: "What we're doing is kind of treading water" (at least on procurement and research and development). Aspin conceded that the Pentagon had delayed making crucial decisions until a "bottom-up" analysis of all weapons and forces is completed later this year. But the ex-Wisconsin congressman's treading-water comment—a gift to headline writers—established the framework for the legislative challenges ahead.

In February, the Pentagon was assigned a budget ceiling of $263.4 billion as part of the Clinton administration's five-year budget package. On March 27, Aspin detailed programs and personnel levels for 1994. But details of the overall five-year plan were to be filled in later. The lack of particulars for fiscal years 1995–1998 were understandable—the new team at Defense had had only a couple of months to put their imprint on the fiscal 1994 budget left behind by the Bush administration. In addition, Aspin was handicapped by health problems and the glacial process of getting new appointees on board.

Senate opponents of military reductions seized on the long-term budget's vagueness to argue that the administration had pulled its numbers out of thin air. New Mexico Republican Pete Domenici, who tried to add $67 billion to the five-year plan, argued on March 22 (before the 1994 details were released): "We would like a defense budget. We would like to see what you proposed to cut. There is no such document." Senate Armed Services Committee Chairman Sam Nunn, who supported the Domenici amendment, added: "What we have are round numbers now without any real detailed map as to how the reductions are going to be made."

The new Pentagon team argues that its decisions are consistent with Clinton campaign pledges to reduce force levels and personnel. The 1994 budget eliminates one deployed aircraft carrier, 30 ships, two army divisions, and four air force fighter wings. The Pentagon also intends to cut military manpower by 108,000, and to reduce the number of U.S. troops stationed in Europe from 164,000 to 133,700 by September 30, 1994.

In addition, Aspin highlighted some new threats to national security that require additional funding and some new budget categories. These programs total $2 billion: $400 million to destroy former Soviet nuclear weapons (the Nunn-Lugar initiative), $40 million to counter nuclear prolifera-

In brief

■ How pyrrhic the victory?
"We did it!" crows a recent press release from INFACT, an organization that led a boycott of General Electric products to protest GE's involvement in nuclear weapons production. The release continues: "After almost seven years of worldwide pressure, GE announced that it is leaving the nuclear weapons business by selling its entire aerospace division. GE's departure means that, for the first time in 50 years, the country's most powerful corporation will no longer be wielding its enormous influence over national policymaking on nuclear weapons!" Well, sort of. It depends on what you consider a "sale." Cash is involved in the transfer of GE's aerospace division to Martin Marietta, but the deal also gives GE 23.5 percent of Martin Marietta stock and two seats on the company's board of directors (*New York Times*, January 23, 1993).

■ Crime pays—too much
Sweden's government has decided to take another look at the wages it pays prisoners. It seems that Russians are traveling to Sweden to commit crimes in order to be jailed. In addition to the customary room and board, Swedish jails pay $8.00 a day, a rate that is highly competitive with wages in the Soviet Union (*Economist*, April 17, 1993).

■ Searching the skies to proselytize
Environmentalists, as well as the San Carlos Apache, a native American group, have opposed the construction of a NASA-sponsored international observatory, which will include a Vatican-owned telescope, on Mount Graham in southeast Arizona. Fr. George Coyne, director of the Vatican Observatory, told the London *Daily Telegraph* that the Vatican is joining with NASA to search for extraterrestrial life. Father Coyne added that if intelligent alien life is found, the church "would be obliged to address the question of whether extraterrestrials might be brought within the fold and baptized" (cited in *The Progressive*, May 1992).

■ No time like the present
Stephen Hawking, the distinguished professor of mathematics at Cambridge University, has trumped a lot of fellow Trekkies—he will make a guest appearance on *Star Trek: The Next Generation.* Hawking was tapped when he visited the Hollywood studio where *Star Trek* is filmed. He was in town to help launch Steven Spielberg's "film version" of his best-selling book, *A Brief History of Time* (*New Scientist*, April 10, 1993).

■ Hazardous waste
The bosses at the nuclear test site's Las Vegas, Nevada, office apparently know how to deal with truly hazardous waste when they see it. The April 1993 newsletter, *NTS News & Views*, issues three edicts: paper recycling boxes are not to be placed in the hallway until the scheduled Thursday afternoon pickup; all boxes are to be placed flush against the wall to minimize tripping; and boxes must be removed if the pickup is canceled.

tion, $300 million for peacekeeping operations, $50 million for disaster relief, $48 million in humanitarian assistance, $50 million for the promotion of democracy and military-to-military meetings, $700 million for conversion, and $420 million for dual-use technology funds to be administered by the Advanced Research Project Agency.

While the defense secretary touts the importance of these programs to meet the emerging threats of the post–Cold War era, his new proposals amount to less than one percent of the $263 billion budget. Some members of Congress, noting the disparity between Aspin's rhetoric and the requested dollars, may try to funnel additional funding into these initiatives, particularly economic conversion, programs to combat proliferation, and international peacekeeping forces.

Aspin's treading-water budget leaves both armed services committees uncertain about which programs may be casualties of the "bottom-up" review. The House Armed Services Committee will face this dilemma when it brings its annual bill to the House floor around mid-June.

The treading-water approach is most obvious in conventional aircraft programs. The Pentagon wants $7 billion in 1994 for six tactical aircraft, all of which are prime subjects for review. Most experts agree that the services will not be able to afford all six, which could cost as much as $350 billion if pushed to completion. While Aspin and his team concede this point, they have deferred a final decision until later this year on the air force's F-22 advanced tactical fighter and F-16 fighter, and the navy's A/F-X carrier-based attack aircraft, F/A-18 C/D Hornet, F/A-18 E/F Hornet, and F-14 upgrade.

House Armed Services Chairman Ron Dellums argued that Congress may have to make its own decisions without waiting for the Pentagon review. The new budget, complained Dellums at a March 30 hearing, "has preserved for another year a host of overlapping weapons programs that cannot all be funded in the future." Nunn echoed those sentiments at an April 1 hearing: "We have the distinct possibility of funding programs that three or four months later may be either canceled or very substantially revised." In response to these comments, Aspin promised to try to come up with specific recommendations before the House-Senate conference on the annual authorization bill concludes in September.

Other programs, including the Strategic Defense Initiative (SDI), will also get a critical look from Congress. Aspin boasted that he had refocused SDI on "real threats," recommending an increase for Patriot-style tactical missile defenses from $1.1 to $1.8 billion. At the same time, anti-missile systems for the continental United States—the proposed ground-based system of six to eight missile-defense sites—was reduced from $1.7 billion to $1.2 billion. Even with these changes, many members still question the need to spend almost $4 billion for a program that they believe should be consigned to the scrap heap.

Another area of controversy may be the future of the few remaining strategic nuclear weapons programs. While the major battles—over the MX and the

Midgetman—are settled, the budget still contains $1.7 billion for the B-2 bomber and $1.2 billion for the Trident II (D-5) missile. Some members question the need for these programs, originally slated to confront communist Russia.

As the budget debate shifts toward expensive conventional programs, another congressional focus may be the navy's prized carrier task forces. The Clinton administration plans to cut one of its 13 carrier task forces. A carrier task force consists of a carrier, supporting ships, and accompanying aircraft. According to the Congressional Budget Office (CBO), the navy could save $650 million this year if it retired not only the single task force Clinton has proposed, but two additional ones. The five-year savings would total $18.1 billion. By outlining a reduction to ten carriers by 1997—other analysts have suggested even deeper cuts—the CBO has incidentally put forward the force level that Clinton proposed during the election campaign.

Several members of Congress want to slash the intelligence community budget, which is about $28–29 billion a year. While campaigning, Clinton called for a $7 billion reduction over five years. The intelligence community, after all, had focused a substantial portion of its budget for the past four decades on a Soviet threat that no longer exists. But in April, the *New York Times* told of a CIA plan to ask for an extra billion dollars to fund new spy satellites. The new chairmen of the Senate and House intelligence committees, Arizona Sen. Dennis DeConcini and Kansas Cong. Dan Glickman (both Democrats), seem skeptical of excessive spy budgets, and they may decide to wield the pruning shears.

Cries of waste, fraud, and abuse may also influence the deficit-cutting mood of Congress. The C-17 cargo aircraft is widely accepted as needed, but the program is at least $1.6 billion over budget, two years late, and still plagued by technical problems. Both the House Government Operations Committee, chaired by Michigan Democrat John Conyers, and the House Armed Services Committee have held hearings on the McDonnell Douglas project. When air force officials and McDonnell Douglas claimed in a hearing on March 10 that the program was turning a corner, Cong. Gene Taylor, a Mississippi Democrat, asked, "How many corners are there in this program?" Aspin, in his March 27 press conference, conceded that he is "disturbed that it [the C-17 program] seems to be bollixed up." A little more than a month later, he gave additional weight to that comment by firing the former C-17 program manager.

The Energy Department's weapons budget is also a potential target for congressional budget cutters. Energy's budget includes $6.1 billion for nuclear weapons work, including $462 million for nuclear testing. But the United States is producing no new nuclear weapons. With unspent funds still available—for weapons tests that will never be held—both the testing budget and nuclear weapons research funding may be tempting targets.

While there are many enticing targets in this year's Pentagon budget, Democrats in Congress may still hesitate to challenge the president's choices. The outspoken Dellums, for instance, has yet to decide whether to wait until he has a year as chair under his belt before pushing for major changes. In the meantime, the hawks must still be reckoned with, and the final shape of military budgets and weapons systems is still very much in doubt.

—John Isaacs

40 years ago in the *Bulletin*

The "News and Notes" section of the June 1953 *Bulletin* reported that a series of Atomic Energy Commission (AEC) weapon tests had been completed at Yucca Flats, Nevada.

A bomb explosion on May 19 caused radioactive particles to fall on the community of St. George, Utah, and residents were asked to stay indoors and traffic was halted. This explosion also marked the first successful flight of a radar-guided plane through the blast cloud. The plane carried monkeys and mice, and the AEC reported that these animals suffered severe radiation effects.

The effect of the blast was tested on the ground by dropping the bomb on a simulated military installation complete with "shaved pigs" dressed in a cloth that was being tested for military use.

Preserving losers' history

Amid last year's cries that the Berlin government was bent on destroying the history of the German Democratic Republic, the city established a "memorials committee" to consider the fate of some 500 monuments, statues, and plaques in East Berlin. (A 60-foot statue of Lenin had been unceremoniously reduced to rubble.) In March 1993, the committee—whose membership was purposely weighted in favor of former East Berliners—began to hand down decisions on which monuments should go, which should stay, and which need to be altered.

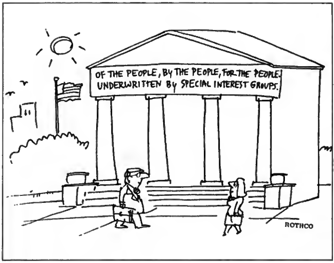
Monuments dedicated to fighting fascism will be preserved—but any inscriptions containing "historically incorrect dogma" will be replaced. Those memorials built by the Red Army will remain, thanks to the German-Soviet "Treaty on Good Neighborliness, Partnership, and Cooperation," signed in 1990 (*This Week in Germany,* March 19, 1993).

On the other hand, the committee recommended that monuments honoring East German border guards should be torn down—quickly. And a tall statue of Ernst Thälmann, once the leader of the German Communist Party, was also slated for demolition. Some statues have already been moved to an outlying memorial "graveyard," where monuments to demoted East German heroes were placed.

Marx-Engels Platz, near the center of the city, is home to the Karl Marx and Friedrich Engels statue, which has been the subject of much debate. The committee recommended that the statue remain for the time being, preferably surrounded by greenery to make it appear "less central" to its surroundings. Historians argued that Marx and Engels were important figures who spoke for the "emancipation of the working class."

Marx and Engels overlook the East German Palace of the Republic (*Palast der Republik*), which will not be preserved. Built in 1976, and closed in 1990 because of asbestos contamination, the building was often known as the *Ballast der Republik* (the republic's encumbrance) or *Palazzo Prozzo* (the ostentatious palace). The most common nickname for the brightly lit building—home of the East German parliament—was *Honeckers Lampenladen*, or Erich Honecker's light shop. A new foreign ministry building will be erected on the site (*This Week in Germany*, March 26, 1993).

—Linda Rothstein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H.L. SCHWADRON

ACDA on the line

The Arms Control and Disarmament Agency (ACDA), created in 1961 by John F. Kennedy, is one of the federal government's smaller agencies. Established to provide the president with independent advice and expertise on arms control issues, the agency has fallen on hard times since Paul Warnke headed it in the Carter years. For a number of years the State Department and the Pentagon have called the shots on such matters as the strategic arms reductions and intermediate nuclear forces agreements.

With the advent of the Clinton administration, the State Department launched an effort to seize ACDA and put it under the assistant secretary of state for international security affairs. While the department analyzed other options as well, its clear message was that ACDA must go. Some observers view State's proposal as a power grab by Lynn Davis, the department's arms control chief. Others, such as Utah Republican Sen. Orrin Hatch, see ACDA as an anachronism in a post–Cold War world, and they hope to make modest savings by disbanding the agency. Arms control, after all, is no longer a high U.S.-Soviet priority. The *New York Times*, in an April 21 editorial, argued that arms control would have greater bureaucratic heft at the State Department.

Not surprisingly, the Clinton administration has failed to find a high-profile ACDA director—who wants to head an agency that may soon sink under the seas? But the quiet battle over this obscure agency picked up steam in March and April as the arms control establishment began weighing in on behalf of the agency. Stanley Resor, former secretary of the army, and John Rhinelander, a legal adviser to the SALT I delegation, organized a group of ex-government officials who called for saving and revitalizing the agency. A number of key members of Congress weighed in as well. When confronted by talk of a split in the arms control community, 17 organizations wrote that moving ACDA to State will mean that arms control issues "are stifled at the bottom of the bureaucratic heap."

ACDA supporters argued that the agency should be given the lead on "new" issues, such as combating nuclear proliferation and promoting the control of conventional arms. This view was reinforced by two studies, one by the State Department's inspector general, and the other by the private Henry L. Stimson Center, both of which analyzed the agency and proposed strengthening rather than terminating it.

Ultimately, ACDA's fate is in the hands of the National Security Council. Under the direction of Robert Bell, a former staffer for Senate Armed Services Committee Chairman Sam Nunn, the NSC will soon forward a recommendation to the president for final action.

—J. I.

Three outrages

The end of the Cold War taxes the Pentagon's ingenuity. Military planners must find creative ways to spend their many billions each year now that the country's prime enemy for four and a half decades has disappeared. Moreover, the United States confronts a new generation of threats for which there are no obvious military solutions. These include fierce international economic competition, the proliferation of weapons of mass destruction, and ethnic strife. But when it comes to spending money, at the Pentagon, necessity is the mother of invention. Consider the following examples.

Item: Navy designers are now considering placing conventional warheads on the Trident II (D-5) missile and using these missiles to attack enemy command posts buried deep in concrete and earth. The navy had planned to spend $16 billion over the next 12 years to purchase 484 new Trident II missiles. (Congress has already authorized the purchase of 295.) In the meantime, the Soviet Union has dissolved and many of the D-5's target silos will be destroyed. With START agreements in hand, there is little need for new nuclear weapons. Thus the navy's desperate search for a way to keep the funds flowing. Cost per missile for this warhead replacement mission would be a mere $20-$30 million. In domestic terms, certainly enough to fund a few new schools.

Item: And what about "Brilliant Pebbles," Edward Teller's scheme to deploy thousands of small orbiting interceptors designed to home in on ICBMs as they race toward the United States? The Soviet missile threat has abated; Defense Secretary Les Aspin and President Bill Clinton have made it clear that they have little use for this once top-priority Bush administration program. Undaunted, air force chiefs are now discussing ways to redirect the program to respond to the threat of Chinese tactical ballistic missiles.

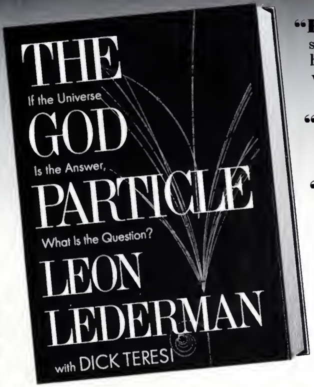
Gregory Canavan, senior scientific adviser at Los Alamos National Laboratory, has suggested that each MX missile could house up to 200 of these small interceptors—thus putting two old Cold War horses to work. Some industry observers have suggested that the real mission of these "Responsive Theater Defense Interceptors" is helping the air force to snatch control of the program from the army—while, of course, continuing to move the gravy train forward.

Item: The nuclear targeteers at Offutt Air Force Base have begun to run out of targets for their thousands of ICBM warheads. While the United States is in the process of reducing the current stockpile of longer-range nuclear weapons from about 8,700 today to 3,500 early in the next century, there are still too many missiles all dressed up with no place to go. The former Soviet Union provided numerous military, political, and economic targets in its vast territories. But the ICBMs cannot target empty missile silos, inoperative factories, and shuttered bases.

Gen. Lee Butler, head of the U.S. Strategic Command, is working on a solution to this dilemma. After intensive computer modeling, he now proposes that the United States consider aiming our nuclear weapons at terrorist strongholds or rogue leaders. Are his computers instructing him to target a southern Lebanese terrorist training base, or the warlords in Mogadishu? Wherever the general identifies new threats, the Pentagon will find reasons to keep its budget swollen beyond the nation's means.

—*J. I.*

John Isaacs is executive director of Council for a Livable World in Washington, D.C., and a Bulletin *contributing editor. Linda Rothstein is the managing editor of the* Bulletin.



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REPORTS

Will South Africa's nuclear program be a model for military conversion? Russia has Chernobyl-contaminated areas too, and many of the residents are fearful; Russia admits it dumped, and will continue to dump nuclear waste at sea

SOUTH AFRICA

A curious conversion

By DAVID ALBRIGHT

ARMSCOR

Advena, where South Africa's nuclear weapons were assembled and stored.

Following President F. W. de Klerk's surprising March 24 announcement—that South Africa had built and then dismantled six gun-type nuclear weapons—Armscor, a government-owned company, revealed that it had operated a secret nuclear weapons manufacturing site—originally known as the Kentron Circle facility, now known as Advena—25 kilometers west of Pretoria. Many analysts had believed that South Africa's national nuclear research center at Pelindaba was the country's nuclear weapons manufacturing site.

Advena had extensive capabilities aimed at building a highly reliable gun-type nuclear weapon deliverable by aircraft. The device was designed to rigorous specifications in order to avoid the need for a full-scale nuclear test. One long-time observer of the South African nuclear program said that it made sense that South African scientists and engineers would have designed the "best crude gun-type device." However, he added, "What does not make sense is that they would have stopped there."

Built during the 1980s, Advena had manufacturing capabilities apparently sufficient to produce more sophisticated nuclear weapons if South Africa had decided to do so. Although there is no evidence that South Africa produced more weapons than it declared, Advena's competencies imply that South Africa was working on more sophisticated designs, including implosion-type weapons. If built, these weapons could have been deployed on advanced delivery systems, such as ballistic missiles, which South Africa was also developing.

After the government abandoned the nuclear weapons program in 1989, Advena was converted to a commercial facility offering high-tech products for the aerospace, mining, medical, and other industries. Advena has become an experiment in the conversion of nuclear weapons-related expertise to the commercial production of sophisticated metallurgical, explosive, electronic, and pyrotechnical products for domestic and export markets.

Following his March 24 announcement, de Klerk invited the International Atomic Energy Agency (IAEA) to inspect Advena and other nuclear weapon sites, and the IAEA responded immediately. In response to queries from the *Bulletin* and *Nucleonics Week*, Armscor said that non-nuclear-specific equipment used at Advena for non-nuclear commercial purposes will be available for IAEA inspections. One IAEA official said he expects Advena to be placed on the list of South African facilities that will be inspected regularly.

According to Armscor, which has supplied an abbreviated history of the South African nuclear program, in March 1971 the Ministry of Mines approved research work on "peaceful" nuclear explosives, which were considered potentially useful to the mining industry.

Until the late 1970s, the South African Atomic Energy Corporation (AEC) was responsible for the development and production of nuclear explosives. A first test device was completed in the middle of 1977, but the program lacked a supply of highly enriched uranium. Armscor said that South Africa planned an August 1977 "cold" (without uranium) test in the

Kalahari desert. But after Western and Soviet intelligence discovered test site preparations, South Africa abandoned the project and sealed the test holes. (Why South Africa would conduct a cold test of a gun-type device underground is unclear; perhaps the test was intended to take place on the surface.)

The next year, still lacking sufficient highly enriched uranium, the AEC built a second, smaller gun-type device that could be tested rapidly once it had enough material. By November 1979, the AEC had produced enough highly enriched uranium at its Y-Plant at Valindaba. The Y-Plant had begun producing highly enriched uranium in January 1978, but technical problems forced its closure from 1979 until 1981.

In fall 1992 *Nuclear Fuel* identified Building 5000 at Pelindaba as the site of early nuclear weapons manufacturing, and it is now believed that the first device was prepared there. On March 26, 1993, the Sunday *London Times* published an interview with a former South African nuclear scientist who was involved in the weapons program until the mid-1970s. He said that when he worked at Pelindaba there were about 30 scientists working on the bomb. He said they worked in secret in Buildings A and D, which were in a high-security compound located well off a road leading to the recreation area at the facility.

In October 1978, the government decided to shift its emphasis from peaceful to military devices. Armscor was given the responsibility for manufacturing, with the AEC providing the uranium. Personnel were transferred to Armscor, although the AEC continued to provide theoretical and health physics support to the Armscor weapons operation.

In 1981, Armscor completed two buildings at Kentron Circle, a main manufacturing building (photo, page 8) and an environmental test facility. The main building manufactured and stored nuclear devices. The environmental test facility was involved in testing the reliability of the device under real-world conditions. This capability was particularly important because the weapons were expected to be reliable without the benefit of full-scale nuclear testing.

A completed nuclear device, made by the AEC and loaded with highly enriched uranium in 1979, was transferred to Advena and stored. According to Armscor, the AEC device was not considered a "qualified" design, which meant that there was not an adequate degree of assurance that it would detonate as intended or that it would not detonate accidentally.

Advena manufactured its first nuclear device in April 1982; the delay probably reflected the problems at the Y-Plant. But even this second device was considered a "pre-qualification" model. Design refinements and final qualification took another two to three years, after which the design was "frozen" for production. When the program was canceled in November 1989, Advena had six devices stored in its security vaults (photo, page 10).

Because of the design's simplicity, because redundancy was built into the device whenever possible, and because Advena had an aggressive qualification program, Armscor was confident that the device would work without a full-scale nuclear test.

It is somewhat difficult to understand why it took so long to "qualify" a device based on simple gun-type principles. But, Armscor said, Advena had to "develop everything in-house due to the security requirements of the program." The device and subsystems were studied carefully to insure that they would be highly reliable and exceed safety requirements. With everything done at Advena, and with stringent specifications, it could easily take several years to accomplish the task.

Although a successful gun-type device is easier to build than an implosion-design weapon, it still presents demanding mechanical and metallurgical challenges. For example, the barrel must be able to withstand the firing of a high-density uranium plug, which is about ten times denser than a normal artillery shell and generates ten times as much pressure on the barrel breach. Even with specialized gun barrels supplied by the navy, the Manhattan Project took a significant amount of time to solve this problem.

Armscor has stated that Advena had problems in the early years in achieving repeatability of projective velocity and repeatability of the symmetry requirements when the projectile is shot into the other subcritical mass; in determining the density of neutron reflectors; and in attaining adequate reliability of the arming and safing devices.

Advena was expanded in the mid-1980s. Additional offices and laboratories were built to accommodate more personnel. But Armscor says no nuclear material ever entered these new buildings. An Armscor spokesman says that Advena not only made nuclear devices, it provided other products and services to other Armscor divisions.

When the nuclear weapons program ended, Advena employed about 300 people. Within a year, that number was reduced to about 110, which is the current level.

On April 1, 1992, Advena became a division of a new commercial group, Denel (Pty) Ltd., which took over 23 of Armscor's 26 subsidiaries and facility companies. (Armscor remains the procurement organization for South Africa's defense ministry and contracts with Denel for military equipment.) Denel rents Advena from Armscor, which has retained ownership of the buildings.

Denel was created in reaction to severe cuts in South Africa's defense budget following peace agreements in the region. The cuts led Armscor, then the tenth largest arms exporter in the world, to make massive layoffs and scrap a number of projects. One of Denel's aims is to find civilian applications for Armscor's development and manufacturing infrastructure, thereby maintaining strong technical capabilities. A key part of this strategy is to keep Armscor's highly skilled workforce from leaving the country. An important goal of this policy is to reduce the likelihood that highly skilled personnel with sensitive know-how will sell their services abroad.

According to Gert Enslin, Advena's general manager, the transition to commercial status gained impetus "when it became clear that a termination of the weapons program was inevitable." When Advena suddenly lost its major product, its survival depended on how rapidly it could develop commercial products. Enslin explained that the overhead costs associated with fixed assets and a highly skilled workforce, customized to the weapons program, were not "conducive to a competitive price structure needed for rapid commercial market penetration." The difficulties of conversion have also been aggravated by the global economic slump of the past few years.

Enslin said that the scientific and technical mindset had to be converted from "technology driven" to "market driven and business oriented." In turn, a new culture had to be created that would support a market and business orientation. An important part of this process, he said, was the creation of new career opportunities.

By 1989, South Africa had six nuclear devices stored in these high-security vaults.

Despite the international embargo on South Africa, Advena developed an extensive array of nuclear-weapons manufacturing capabilities. By the time the program ended, Advena had extensive capabilities in high explosives, theoretical calculations, metallurgy, high-speed electronics, environmental and reliability testing, and ultra high-speed diagnostics.

Advena seems a good deal more capable than a gun-type device would have required. According to one nuclear weapons expert, the type of technology and high-explosive capabilities at the site are "not normally associated with gun-type bombs."

There is no evidence that more sophisticated weapons, such as implosion-type nuclear weapons or miniaturized devices, were ever produced. But Advena personnel appear to have been working on those types of weapons. Whether any parts for such devices were developed is unknown at press time.

Advena's current product line includes sophisticated high explosives for mining and other applications. Advena could make specially shaped explosive charges for implosion weapons. According to one of its advertising brochures, Advena can custom design high explosives to produce shaped shock waves. According to the December 4, 1992, *Engineering News* (South Africa), Advena's Cone-Pak "is easily applied, requiring no drilling. It produces little fling rock and is suitable to be used near underground services."

Other specialties include explosive shaping of metals and explosive welding of metals normally considered incompatible using conventional welding methods. One U.S. official familiar with these processes said that explosive welding and forming is "tough to do," and it implies a high degree of knowledge about using high explosives.

Advena has fully instrumented test facilities that can handle indoor detonations of 10 kilograms of high explosives, and its environmental test facility is licensed for components and systems containing up to an equivalent of 30 kilograms of TNT.

According to *Engineering News*, Advena maintains clean rooms for the production of ultra-reliable electronic modules complemented by environmental test facilities that can simulate a wide range of vibration, temperature, humidity, and pressure conditions. Consultation on electronic and structural design is also available. Advena has a test oven that can simulate humidity and pressure at 50,000 feet, with a temperature range from -60 to 130 degrees centigrade.

Advena also has extensive metallurgical capabilities. Its conventionally formed thin metal plates and sheets require little finishing. It also has powder metallurgy capabilities. And Advena is the sole source of tungsten composites in South Africa. (Tungsten was used as a neutron reflector in the gun device.) Advena also has a hot isostatic press that can compact castings into high integrity products. The press also shapes metals that are hard to forge and cast conventionally. (Such a press can be used to form beryllium metal and tungsten carbide into reflectors for nuclear devices.)

The site also produces permanent rare earth magnets, which could be useful to uranium centrifuge programs. The major type, cobalt samarium magnets, are used in the top magnetic bearing of a centrifuge. Iraq's secret uranium centrifuge program acquired cobalt samarium magnets from European suppliers.

The facility also produces pyrotechnical products that can produce detonation-driven automatic decoupling, activating, and safeguarding devices, as well as "strategic pyrotechnical products."

South Africa invested heavily in Advena when it was a nuclear weapons manufacturing site. Its present management is working to develop attractive commercial products.

Advena's output—particularly its exports—needs to be scrutinized to insure that it does not contribute, directly or indirectly, to another country's nuclear weapons program. In addition, the South African government needs to insure that former or current employees do not provide sensitive know-how or services to other nuclear weapons programs.

At a minimum, the IAEA should periodically inspect Advena, and the South African government should join the Nuclear Suppliers Group and agree to abide fully by its guidelines for exports of nuclear and "dual-use" technology, equipment, and products. ■

David Albright, the president of the Institute for Science and International Security in Washington, D.C., is a Bulletin *contributing editor.*

CHERNOBYL

Perceptions of peril

By GLENYS A. BABCOCK

It is not unusual to read articles by nuclear scientists or government officials who describe the general population as suffering from "radiophobia" or "radiohysteria." But a recent survey of attitudes in the regions of Russia contaminated by the 1986 Chernobyl accident appears to refute the conventional wisdom that it is ignorance that breeds fear.

In a random sample, 67 percent of those with an elementary school education expressed fear of nuclear power stations. But the percentage who said they felt at risk rose to 81 among those with higher education. Left unanswered is the question of whether specific education about radiation and nuclear power plants would or would not increase the population's level of anxiety.

This is just one finding of a survey by Alla Mozgovoi and Gennadi Denisovski, completed in 1992 at the Institute of Sociology of the Russian Academy of Sciences. Residents were randomly selected from eight of the 24 districts, or *raions*, identified by the Ministry of Health as being the most severely contaminated by radiation from Chernobyl. The survey results expose the social and psychological impact of the Chernobyl accident in western Russia. (Most Western investigators have focused their attentions on the larger contaminated areas in Ukraine and Belarus.)

The residents of the districts surveyed reported an exceptional number of health problems and expressed a high degree of concern about their health. In response to questions about the accident's effects on their personal health, 75 percent of those polled complained of exhaustion, and 70 percent said they experienced headaches and dizziness. Many admitted they were having psychological problems—70 percent cited irritability; 57 percent felt fear and a sense of helplessness, and 48 percent described themselves as depressed and apathetic. A majority had an unshakable fear of the continuing effects of the accident; almost 60 percent said they were afraid to eat fresh produce or to drink the water because of possible radiation contamination.

Those surveyed did not think of their reactions as unique: More than 80 percent believed that their communities as a whole had had more illnesses since the accident; 39 percent said that the birth rate in their community had fallen, and 69 percent said that the death rate had risen.

One very striking consequence of these widespread beliefs was the finding that 20 percent of adults—as well as 11 percent of teenagers—reported that they had decided not to have children because of concerns about the possible health problems their offspring might have.

The survey revealed somewhat contradictory attitudes about nuclear energy. On the one hand, 91 percent of adults believed that radiation causes cancer, and over 80 percent thought that another nuclear power plant accident was possible. (Most of the nuclear power stations in the former Soviet Union are located in Ukraine and western Russia, near these communities.) Three quarters of the adults and more than half of the teenagers surveyed said they feared nuclear power plants, and almost nobody thought that the plants would be made safe enough to eliminate the danger of more accidents in the near future. On the other hand, nearly 40 percent believed that nuclear energy "must" continue to be developed, and about one-third thought that nuclear power would give their country economic and political independence.

While responses taken in the aggregate suggest a high degree of overall concern, when the results are examined district by district, an extraordinary variation becomes apparent—one that cannot be explained by the district's distance from Chernobyl.

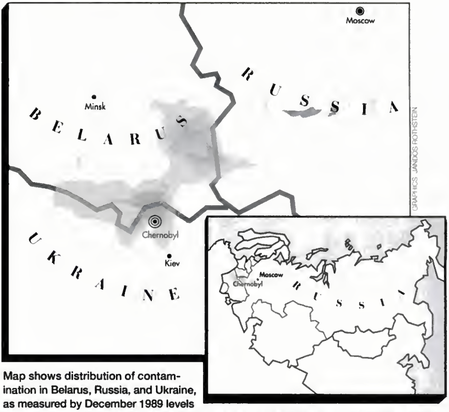
In particular, the availability of information about the accident was very different in each district. Although 62 percent of those surveyed said they found out that their community was contaminated in 1986, a breakdown by district shows that 96 percent of the residents of Novozybkov knew in 1986, while only 28 percent of Belev and 22 percent of Uzlovaya knew of local contamination in 1986. By the end of 1989—almost four years after the explosion—27 percent of those in Belev and 23 percent of those in Uzlovaya still did not know that their town had been contaminated. It was not until the end of 1990 that 95 percent or more of the adult population knew that Chernobyl had contaminated their community.

One reason for these differences

might be the wide variation in the number of public meetings with government officials and health workers. In Zalegoshche, only 10 percent of the respondents reported that health workers had met with the public one to three times since Chernobyl. Almost half of those polled in Zhizdra said that health workers had met with the public between one and three times, and another 25 percent in Zhizdra said these workers had visited quarterly or monthly.

Those surveyed were asked about accident-related medical checkups. Only 20 percent of Belev residents and 33 percent of Zalegoshche residents said there were post-accident medical checkups in their districts. In Zhizdra and Novozybkov, 90 percent of the population said there had been medical examinations.

Differences in the quantity of medical care and numbers of meetings with health workers are strongly associated with differences in perceptions of the state of health of community residents. In Zhizdra and Novozybkov, which had the highest rate of medical care, fewer of those polled thought that the rates of illness and death were increasing. Whether this means that health care led to better health, or that the mere presence of medical workers and the opportunity for discussion reduced health concerns, is not clear. From a social policy perspective, it is useful to note that increased contact with medical workers is associated with decreased stress and fear.



GRAPHICS: JANDOS ROTHSTEIN

Map shows distribution of contamination in Belarus, Russia, and Ukraine, as measured by December 1989 levels of cesium 137. Novozybkov is near the Ukrainian border; Belev and Uzlovaya are at the eastern edge of Russia's contaminated area. Adapted from International Chernobyl Project map, International Atomic Energy Agency, 1991.

A significant proportion of those surveyed felt poorly informed about the specific effects of radiation; others seemed overly confident. When asked how much they knew about the effects of radiation on human health, 21 percent reported that they knew almost nothing or nothing at all. Another one-third replied that they "knew everything" about the effects of radiation. This seems to be an astonishing number, given that there is no consensus or even broad agreement among experts on the long-term effects of radiation on humans.

At first glance, Novozybkov appears to have been exceptionally well informed. In 1986, nearly everyone knew that the community had been contaminated, and over the next several years a significant proportion of the population knew about public meetings and medical checkups related to the accident.

But when asked specific questions about the content of the information they received, residents of Novozybkov gave highly contradictory responses. Forty-one percent said they were forbidden to sell vegetables or beef; 42 percent said it was not forbidden. When asked whether a decision had been made to resettle the community, 41 percent said yes and 47 percent said no. When asked if the production of farm products was forbidden, 38 percent said yes and 51 percent said no—and fewer of Novozybkov's residents chose the "don't know" category than those in any other town. Thus, despite the relatively high level of attention paid in Novozybkov to the accident, its inhabitants were no more educated about their health and the situation as were residents of other communities.

When it comes to promoting a sense of well-being, action seems to have been more important than information. Fewer people in Zhizdra than in any other district (only 15 percent) wanted to move because of the threat of radiation. The key difference between Zhizdra and other districts may be that a high proportion of Zhizdra's respondents reported that the authorities not only held frequent public meetings, but they also engaged in a number of concrete activities—measuring radiation, conducting medical screenings, and monitoring the quality of food.

While the study raises many more questions—one can only speculate about the consequences of widespread feelings of personal and community deterioration, and the fear of cancer and an early death—it is an important first step in understanding the social consequences of the accident at Chernobyl. So far, most research has focused on the task of measuring and treating the physical effects of radiation. This survey should remind us that the perceptions of those affected by Chernobyl also have important implications for society. ■

Glenys A. Babcock is a doctoral candidate at the RAND Graduate School and a fellow at the RAND/UCLA Center For Soviet Studies in Santa Monica, California.

NUCLEAR DUMPING

Lies and incompetence

By SERGEI LESKOV

At the end of March, a Russian government commission revealed the full extent of the former Soviet Union's practice of dumping radioactive waste into the seas and oceans surrounding its territories. The commission was led by Aleksei Yablokov, an environmental expert and adviser to President Boris Yeltsin. Other members included the directors of the ministries of defense, atomic energy, national security, and foreign affairs.

The report, the first example of Russia's new openness about its ocean dumping, completely reverses the former Soviet Union's official position, announced in 1985, that the Soviet Union never dumped, was dumping, or intended to dump, radioactive materials into the sea. (Even in 1989, after glasnost, the Soviet Union denied any dumping when asked by the International Atomic Energy Agency (IAEA). Although the Yablokov report's calculations of the actual radioactivity of ocean-dumped wastes are preliminary, the report marks the first time since 1917 that the Soviet (now Russian) government has agreed with independent international organizations about the former Soviet Union's internal pollution problems.

The report acknowledges that the former Soviet Union buried 18 nuclear reactors at sea, and that nuclear fuel was not removed from six of them. Sixteen of the sunken reactors (including the six with fuel) are in the Arctic's Kara Sea, where nuclear waste dumping is prohibited by international law. The other two reactors are in the Sea of Japan. A reactor screen (with 125 irradiated fuel assemblies) from the Lenin (a nuclear ice-breaker) was also sunk in the Kara Sea.

As a result of four accidents from 1968 to 1989, five Soviet nuclear submarines with their reactors were sunk in ocean waters adjoining or near the Hawaiian Islands, the Bay of Biscay, Bermuda, and the Norwegian Sea. The report also noted a total of some 50 radioactive objects from other nuclear countries that reside in various oceans.

Liquid radioactive waste was regularly dumped in Arctic seas. Some 319,000 curies of radioactive waste was emptied into the Barents Sea; 2,419,000 curies of waste was dumped into the Kara Sea; and 19,000 curies of radioactive waste was unloaded along the Russian Pacific coastline.

The London Dumping Convention, created in 1972, forbids disposal at sea of all highly radioactive waste products. Disposal of low- and medium-level waste was permitted with special permission from the International Maritime Organization if these IAEA requirements were met: dumping must be beyond the edge of the continental shelf, at a depth of at least 4,000 meters, and only between the latitudes of 50 degrees north and 50 degrees south. The only waters in the former Soviet Union that meet these specifications are along Russia's Pacific coast. However, international observers suspected for a long time that the northern fleet was turning the shallow Arctic seas into a gigantic and uncontrolled radioactive burial ground.

During subsequent London conventions (in 1983 and 1985) signatories agreed to a voluntary moratorium on all types of radioactive waste disposal at sea. According to the IAEA, from 1949 to 1982 Britain dumped 74,000 tons of radioactive waste in the North Atlantic, the English Channel, the Bay of Biscay, and waters around the Canary Islands. Much of it was low- and medium-level materials from nuclear power stations, such as the one at Sellafield. Of the estimated 3.7 million curies of radioactive waste that various countries have dumped at sea, Greenpeace estimates the former Soviet Union is responsible for 2.5 million curies, Great Britain for 906,000 curies, and the United States for 76,800 curies, although the U.S. figure may be somewhat understated.

During a Moscow press conference at the end of March, Yablokov said: "We cannot identify the level of danger in the ocean, because we do not have objective data on how radioactivity penetrates the ecosystem. Perhaps nothing terrible will happen. However, it is not impossible that substantial radioactivity will get into fish that man consumes."

The commission concluded that the level of radioactive pollution in the oceans had not yet increased to dangerous levels, but noted that it may be too early to predict the ultimate effects of the dumping. The Russian military fleet used a variety of containers to bury the radioactive waste. Many were made of alloys that undergo electrolytic reactions in sea water and corrode quickly, according to the report, which estimates that the metal containers will be breached in about 10 years, concrete in 30 years. The submarine *Komsomolets*, sunk in 1989 in the Norwegian Sea, is made of steel and titanium and is especially dangerous. According to eyewitness accounts, it was not unusual for containers to be shot full of holes so they would sink faster.

The Yablokov commission reports that Russia possesses 235 ships and submarines with a total of 407 nuclear power reactors—60 percent of the world's naval reactors—and that radioactive waste from these ships will continue to be dumped at sea because of Russian disposal problems. There is a catastrophic shortage of depots for radioactive waste in the fleet's shipyards. Russia's northern and Pacific fleets have already accumulated 30,000 thermal exhaust assemblies from atomic submarines—but there are only 600 depots available now and probably for a decade into the future. (Normal military submarine servicing

(continued on page 55)

A PROLIFERATION PRIMER

By DAVID ALBRIGHT

Some might argue that the devastation of Iraqi society was a fair trade for keeping a nuclear weapon out of a ruthless murderer's hands—especially if it deterred other murderers. Iraq's nuclear potential has often been exaggerated, sometimes to justify military action, and at other times to bolster U.N. inspection efforts, but the Gulf War did unmask a determined, well-funded nuclear-weapons program that had largely escaped detection. If the war had not led to the program's destruction, Iraq might soon have had its first nuclear weapon.

It's obvious that peaceful means of blocking nuclear proliferation—the Nuclear Non-Proliferation Treaty (NPT), nuclear supplier controls, and the International Atomic Energy Agency (IAEA) safeguards system—failed to detect the Iraqi nuclear program or to stop it. But "bombing to stop the Bomb" is not the way to end proliferation.

If the nonproliferation system is going to work, existing approaches will need to be improved and expanded. Governments and international organizations will need to improve their ability to detect the existence and status of nuclear-weapons efforts in threshold countries and among terrorist groups.

Detecting small, dedicated nuclear facilities is difficult, and the record is mixed. Although many secret programs have been detected and thwarted, several important programs have eluded detection. In some cases, the failure stemmed from inadequate monitoring; in others, from a lack of political commitment.

Better national and international monitoring is needed for the verification of existing agreements, particularly of the NPT. In some cases, clandestine nuclear-weapons efforts may not violate international agreements. Yet their early detection is in the interests of global security. Monitoring is becoming more complicated as the breakup of the former Soviet Union aggravates the problem of containing its stocks of weapons, materials, and technology.

Finding small nuclear facilities is difficult, and the record is mixed. Many secret programs have been discovered, but several important programs have escaped detection.

Successful and early detection of future weapons efforts will require more resources, increased sharing of intelligence information, and the maintenance of a high political commitment to stemming proliferation. These efforts would be significantly easier if there were greater transparency about all nuclear programs—including their inventories of plutonium and highly enriched uranium, and their capability to make these materials.

Monitoring

There are two independent approaches to detecting secret nuclear activities. The first is the IAEA safeguards system, which now monitors nuclear material at some 900 declared nuclear facilities in more than 50 countries. This verification system entails a combination of on-site inspections, materials accounting, and containment and surveillance. In the non-nuclear weapons states, this system is intended to expose any use of civilian facilities for weapons purposes or the diversion of its nuclear material. And any facility in a non-nuclear weapon state that is not safeguarded is spotlighted as a

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David Albright is president of the Institute for Science and International Security in Washington, D.C., and a Bulletin *contributing editor.*

suspected nuclear weapons site.

The second approach involves a melange of top-secret methods used by intelligence agencies. Techniques include communication intercepts, export monitoring, human intelligence, high-resolution photography, and detailed analyses of publicly available information.

In 1970, when the NPT was first brought into force, these two approaches were viewed as adequate. The telltale sign of a nuclear-armed country was an easily detectable full-scale nuclear test. With little civilian plutonium or highly enriched uranium in circulation, IAEA safeguards of the civilian nuclear industry were considered straightforward.

But now the situation is much more complex. The cases of Pakistan and South Africa show that it is not necessary to conduct a full-scale nuclear test to be a nuclear-armed power. And the Gulf War revealed the inadequacies of traditional IAEA safeguards and intelligence gathering.

Iraq is considered an intelligence failure because large-scale nuclear weapons activities were not discovered by the IAEA or Western intelligence agencies. The reasons for this failure, however, involve more than a deficiency in either safeguards or intelligence-collection methods.

Western governments did not aggressively pursue leads about Iraqi nuclear efforts or seriously impede Iraq's nuclear program during the 1980s. Most Western governments supported Iraq over Iran in their bloody war. Many European countries—Iraq's major source of critical equipment and technology—strongly resisted tightening controls on exports to Iraq and to other developing countries. Although export controls were being strengthened by the late 1980s, the new controls were too late to stop Iraq.

Despite a failure to detect the full scope of Iraq's program, intelligence agencies knew enough before the Iraqi invasion of Kuwait to have justified some sort of intervention. But Western governments were unwilling to risk the kind of political confrontation that they had with North Korea in the late 1980s and early 1990s. Tight export controls and more thorough international intelligence-sharing would undoubtedly have revealed more precise and complete information about Iraq's weapons program.

Post-war inspections

Fearing a repetition of past failures, after the Gulf War the U.N. Security Council decided to coordinate intelligence efforts with on-site inspections. This coordinated inspection effort, conducted under U.N. Resolution 687, has laid bare—and nearly destroyed—Iraq's nuclear program, despite Iraq's frequent refusals to cooperate and its attempts to disguise or hide major portions of its program.

Intelligence agencies have shared their carefully guarded information with the IAEA and the U.N. Security Council. These agencies have provided the IAEA and the United Nations with invaluable information from defectors, export transaction records, and analyses of high- and low-altitude imagery.

The IAEA action team has gone beyond the IAEA's normal safeguards approach, conducting on-site, no-notice inspections of undeclared facilities based on intelligence information. As a result of these inspections, governments have received detailed information about the Iraqi program.

The IAEA inspectors have seized tens of thousands of pages of documents, and analyzed and sealed hundreds of nuclear-related components and pieces of manufacturing equipment. Analyses of these items have been invaluable in gauging the scope and status of Iraq's nuclear program.

The action team also picked its own inspectors—another departure from IAEA routine. This freedom allowed the choice of experts from member states with expertise in all facets of nuclear weapons production. One team even included lock-pickers, to allow the team quick access to a secret design center in Baghdad.

Inspectors regularly interview experts from the Iraqi nuclear programs. Although the Iraqi experts are often uncooperative, particularly about their procurement networks, they have provided detailed information and insights into their programs.

To carry out Security Council-mandated long-term monitoring, the IAEA has begun implementing techniques to detect any resumption of the Iraqi nuclear program. One system will monitor Iraqi waterways for chemical and radioactive effluent that might be emitted by secret nuclear facilities. During the fifteenth inspection in November 1992, inspectors collected enough data to establish a baseline against which they will compare future measurements.

Another procedure that is being implemented is periodic monitoring of Iraqi dual-use equipment. Although the IAEA has traditionally verified quantities of nuclear materials, it has no mandate to verify the location or use of dual-use equipment. As another way to detect signs of suspicious activity, the IAEA has asked the Nuclear Suppliers Group to give the team data on their exports to Iraq.

Although U.N. resolutions since the Gulf War established an inspection regime in Iraq that has made it possible to learn a good deal about that country's nuclear program, it is unlikely that the nuclear inspection arrangements instituted in Iraq would be accepted elsewhere. Nevertheless, the Iraqi experience has led to a better understanding of the level of monitoring and inspection needed to detect and prevent nuclear weapons activities. This episode has also led to a better understanding of the paths that other nuclear aspirants have followed. The most difficult part of building a nuclear weapon lies in acquiring fissile material—either separated plutonium or highly enriched uranium.

Plutonium

The indigenous production of plutonium requires a major industrial infrastructure, including at least a 20–40 megawatt (thermal) reactor. A supply of uranium must be developed, as well as the ability to convert the uranium into fuel. Inside the reactor, the uranium fuel is irradiated, and plutonium is produced by neutron capture in uranium 238. The irradiated fuel is then sent to a heavily shielded chemical processing facility where the plutonium is separated from the uranium, transuranic elements, and fission products. All of these processes generate large quantities of nuclear and chemical waste that must be safely stored.

Although the technology is readily available, the successful construction and operation of a group of facilities to produce plutonium is demanding; it requires specialized materials and thousands of workers to build and operate the varied facilities.

One of the most difficult and most visible steps is acquiring or building a reactor large enough to produce significant amounts of plutonium. Even with outside assistance, it is likely to take several years to finish the reactor.

Another difficult step is acquiring a separation capability. The principle separation technology is called the PUREX (plutonium-uranium extraction) method, which involves dismantling and chopping up the irradiated fuel, dissolving it in hot nitric acid, and then partitioning the plutonium and the uranium with a technique known as "solvent extraction." Tributyl phosphate diluted in kerosene is commonly used as the solvent in the PUREX process.

Major "signatures" of clandestine plutonium production are: the reactor's cooling towers, a large labor force, the importation of specialized equipment or materials, the high heat output of an operating reactor, the extensive radiation shielding needed for even a modest plutonium separation facility, and the large amount of nuclear emissions and waste being generated.

North Korea. The case of North Korea illustrates that a small (5 megawatt-electric) reactor, large enough to produce enough plutonium for one bomb a year, can be detected before it begins operating. North Korea is believed to have started building a small reactor at Yongbyon in 1980; it began operations in 1986. The reactor, based on 1950s Magnox reactor technology, has a graphite moderator and gas cooling that North Korea developed indigenously.

By 1984, the United States had learned of the existence of this secret reactor. The methods used to discover it are not publicly known, but they would undoubtedly have included a range of techniques, including satellite surveillance. The United States subsequently discovered that North Korea was building larger reactors of the same type.

In the late 1980s, the world learned that a large, secret reprocessing plant was being built near the small reactor at Yongbyon. Although there was some controversy over whether this heavily shielded facility was a full-scale reprocessing plant, in 1992 North Korea told the IAEA that it was, although the North called it a "Radiochemical Laboratory." Some who did not believe that the Yongbyon facility was a reprocessing plant thought that the North was building an underground plant elsewhere, and that the building at Yongbyon was a decoy. North Korea denies that it ever built a smaller, pilot-scale plant, and no evidence for such a facility has emerged.

During the IAEA's inspections in spring 1992, North Korea admitted that it had separated gram quantities of plutonium in March 1990 at the Yongbyon plant. The North said the plutonium came from failed fuel elements taken out of its 5-megawatt electric reactor.

Based on friendly intelligence, in 1992 the IAEA asked to visit a facility in the capital, Pyongyang. The North subsequently admitted that it had separated minute quantities of plutonium in 1975 in Pyongyang in hot cells provided by the Soviet Union as part of the supply of a research reactor. This plutonium is believed to have been produced in the Soviet-supplied research reactor. The facility is considered too small to be a pilot plant.

Based on analyses of plutonium and waste samples, the IAEA has concluded that the North has separated more plutonium than it has declared. By early March 1993, the IAEA had been unable to estimate the total amount of plutonium that might have been separated, and the North had refused to admit to any other separation activities. In reaction to international pressure, on March 12 North Korea announced that it intended to withdraw from the NPT.

Israel. During the late 1950s and early 1960s, France is reported to have secretly supplied Israel with a nuclear reactor and an underground plutonium separation plant. U.S. intelligence learned of the reactor's existence during its construction. Questions remain about its historical power rating.

U.S. intelligence agencies apparently strongly suspected that there was a reprocessing facility at Dimona in the 1960s. But more complete details were not revealed until 1986, when Mordechai Vanunu, a former nuclear technician at the separation plant, told his story to the London *Sunday Times.*

The total amount of plutonium produced at Dimona can only be estimated. Intelligence estimates are certainly more exact, although they are not publicly available. According to *World Inventory of Plutonium and Highly Enriched Uranium 1992*, Israel is estimated to have produced about 240 to 415 kilograms of weapon-grade plutonium through 1991.[1]

India. India has the most transparent unsafeguarded plutonium production program of the developing nations. The centerpiece of the program includes two heavy-water reactors and a plutonium separation plant at the Bhabha Atomic Research Center near Bombay. Although the Indian government regards information about the amount of plutonium it has separated as classified, *World Inventory of Plutonium* estimates that India had accumulated almost 300 kilograms of separated weapon-grade plutonium by the end of 1991.

Iraq. After the Gulf War, IAEA inspectors uncovered a plutonium separation program based on the use of a safeguarded fuel fabrication plant, a

SECRET PRODUCTION PLANTS

	Technology	Plant	"Significant" activity began	Plant revealed	How revealed	Revealed before operating?
Argentina	Gaseous diffusion	Pilcaniyeu	1978	1983	Announced	no
	Plutonium separation	Ezeiza	1978	1978	Announced	yes
Brazil	Centrifuge	IPEN	1978	early 1980s	Intelligence	no
	Centrifuge	Aramar	early 1980s	mid-1980s	Announced	yes
Iraq	Calutrons	Tuwaitha	early 1980s?	1991	Defector/inspection	no
	Calutrons	Tarmiya	mid-1980s	1991	Defector/inspection	no
	Centrifuge	Tuwaitha	early 1980s	mid-1980s	Iraqi declaration	no
	Centrifuge	Rashidiya	late 1980s	1992	Defector/inspection	no
	Centrifuge	Al Furat	late 1980s	1991	Iraqi declaration	yes
	Plutonium separation	Tuwaitha	late 1970s	1991	Inspection/declaration	no
India	Plutonium separation	Trombay	1950s	1950s	Announced	yes
	Centrifuge	Trombay	1980s	1980s	Announced	yes
	Centrifuge	Mysore	early 1980s?	mid-1980s	Intelligence	yes
Israel	Reactor	Dimona	mid-1950s	late 1950s	U.S. intelligence	yes
	Plutonium separation	Dimona	mid-1950s	1960s?	U.S. intelligence	?
North Korea	Reactor	Yongbyon	1980	1984	Intelligence	yes
	Plutonium separation	Pyongyang	before 1975	1992	IAEA inspection	no
	Plutonium separation	Yongbyon	1980s	late 1980s	Intelligence	yes
Pakistan	Centrifuge	Kahuta	mid-1970s	late 1970s	Intelligence	yes
South Africa	Aerodynamic separation	Valindaba	1970	1970	Announced	yes

"Quick! Write that down!"

research reactor, and hot cells at the Tuwaitha nuclear research center. IAEA safeguards had failed to detect the separation of a tiny amount—about 5 grams—of plutonium.

Despite months of searching, the IAEA has not found a dedicated Iraqi plutonium separation program rumored to include an underground reactor. The rumors still persist, and periodically IAEA inspectors visit suspect sites. Given the scope of the Iraqi program and the information uncovered so far, it seems logical to assume that Iraq at least thought about building a secret reactor and separation plant.

Enriching uranium

There are a number of ways to enrich uranium, although building enrichment plants requires extensive design and installation of large amounts of costly equipment. The two major commercial methods are gaseous diffusion and gas centrifugation. Other methods include aerodynamic techniques, the chemical approach, electromagnetic separation, and—still under development—laser separation. All approaches require a supply of uranium, which must be acquired either through indigenous production or foreign purchase.

Enrichment technology is not widely available, although early electromagnetic methods have been declassified. Europe's Urenco centrifuge technology has become more available over the years.

- **Gaseous diffusion.** This technique exploits the fact that in gaseous form, heavier molecules travel more slowly than lighter molecules. As a result, the latter will strike a permeable wall more frequently, and the escaping gas will contain more of the lighter component. In a gaseous diffusion plant, uranium hexafluoride emerging from the end of a diffusion stage will be slightly enriched in the isotope uranium 235. Enriching it to weapon grade (90 percent or more) typically requires several thousand stages.

This method is highly energy intensive and it requires large facilities, making detection of a fully operating facility at least theoretically straightforward. A British gaseous diffusion plant at Capenhurst, with a capacity of about 500,000 separative work units (a standard measure), was about 500 meters long and required several large cooling towers to dissipate residual heat.

Diffusion barriers and pumps must be made of materials that can withstand the corrosive effects of uranium hexafluoride; the technology for developing such material and equipment is not generally available.

Argentina. Argentine nuclear officials surprised the world in 1983 when they announced that Argentina had been building a secret gaseous diffusion plant in the town of Pilcaniyeu in a remote section of Argentina. Officials said that the plant had already produced a small amount of enriched uranium.

The announcement revealed the limits of remote intelligence gathering. An official involved in building the plant said that Argentina had thrown off Western intelligence agencies by encouraging them to look for a nonexistent plutonium production reactor. Argentina was already known to be building an unsafeguarded reprocessing plant.

A U.S. official said that remote surveillance had made the United States suspicious of the construction at Pilcaniyeu, but the building's purpose was unknown. About six months before the 1983 announcement, some U.S. officials wanted to ask the Argentine government about it, but their superiors considered such an action inappropriate.

The enrichment plant was built using primarily indigenous capabilities in order to reduce the chance of outside discovery. According to Adm. Carlos Castro Madero, then head of the Argentine atomic energy commission, Argentina decided on gaseous diffusion because it had the industrial infrastructure to build the key components itself.

The Pilcaniyeu plant remains unfinished, beset with delays produced by budget cutbacks and technical difficulties. Despite the delays, the plant has produced an unknown quantity of low-enriched uranium.

Iraq. During the early 1980s, Iraq conducted a secret feasibility study on gaseous diffusion, including some laboratory work on barrier material. By 1987, the effort had failed and it was abandoned in favor of other approaches. The Iraqis found the technology too technically demanding and were unable to obtain outside assistance.

■ **Gas centrifuge.** In this method, the heavier molecules in a rotating gas move toward the inside wall of the rotating tube. An induced countercurrent in the gas increases the separation of uranium 235 from 238. A gas centrifuge plant can be somewhat smaller than a gaseous diffusion plant. It uses less than a tenth of the electricity consumption of a gaseous diffusion plant.

Once operating, a centrifuge plant has few unique signatures, so it is difficult to detect. One method of detection involves looking for a high-frequency electromagnetic signal radiated by motors running the centrifuges. Depending on the plant's design, however, this signal might be too weak to find, unless the detectors are nearby.

Because the centrifuges spin at supersonic speed, precision engineering and metallurgy are critical for success. Most developing countries require outside assistance, and Western monitoring of a trail of suspicious or illegal exports has often led to the detection of secret centrifuge programs.

The items intended for a centrifuge program can be readily identified: special materials such as maraging steel or advanced fibers; high-quality computer numerically controlled machines; and other specialized items, including special oils and magnets; and large quantities of aluminum piping.

Although the Urenco centrifuge (developed by a European consortium) has a remarkably simple design, operation requires mastery of complicated details. If these are not resolved properly, the centrifuge will be damaged. (A small, light-weight spinning centrifuge can contain the kinetic energy equivalent of a 10-ton truck traveling at 50 kilometers an hour.)

Export monitoring may reveal the existence of a centrifuge program, but it will rarely provide conclusive information about the locations of centrifuge research, development, and production facilities. Nevertheless, facilities in Brazil and Pakistan were identified before significant quantities of enriched uranium were produced.

Pakistan. Pakistan was the first country that used stolen European centrifuge designs and large procurement networks to acquire a gas centrifuge plant and associated facilities. It kept its program, begun in the mid-1970s, secret for a few years. This secrecy, coupled with weak Western export controls, enabled Pakistan to get a head start on accumulating large quantities of material, equipment, and components before Western governments took steps to stop its program.

Since the mid-1970s, Pakistani procurement agents managed to use circuitous buying patterns to stay ahead of slowly tightening Western export regulations, enabling them to acquire additional critical items. Pakistan has willingly broken export laws in the United States and in Europe, leading to some well publicized arrests of Pakistani procurement agents.

During the late 1980s, Pakistani scientists published a series of technical articles about certain aspects of manufacturing Urenco-type centrifuges that imply that Pakistan's program has been successful.

Pakistan's Kahuta enrichment plant is believed to have produced weapon-grade uranium. According to *World Inventory of Plutonium*, Pakistan is estimated to have produced about 120–220 kilograms of weapon-grade uranium by the end of 1991.

Iraq. The Iraqi centrifuge program was known to Western intelligence before the Gulf War, primarily because of Iraqi procurement efforts. After the Gulf War, many details emerged about what had been procured, where Iraq planned to produce its centrifuges, and when it expected to have an operational centrifuge plant.

At the time of the war the centrifuge program was at an early stage, using clandestinely acquired European designs, materials, manufacturing equipment, and components to conduct single-machine tests. There is no evidence of a secret cascade of machines, although a few centrifuges might have been connected together. Iraq intended to build cascades by the mid-1990s.

A disturbing aspect of the Iraqi program is that it appears to have purchased an early centrifuge design, and then independently bought the services of experts to improve the design. A German centrifuge expert who was involved in helping Iraq in 1988 and 1989 believes that Iraq probably acquired the design on the international "gray market." He believes that the likely source was Pakistan, although he thinks that Iraq probably acquired the design through a third party.

Armed with the design and foreign technical advisers, Iraq was buying sophisticated manufacturing equipment in Europe, including numerically controlled machine tools that were then programmed to produce centrifuge components automatically and precisely. The use of these machines would have significantly lessened the need for skilled technicians.

Although Iraq's centrifuge program is believed to have been destroyed by the war and subsequent IAEA actions, important questions about the program remain. The inspectors have not learned the full extent of knowledge and experience acquired by Iraqi centrifuge experts. Important portions of Iraq's foreign procurement network are only partially understood. Answering these remaining questions would settle once and for all whether Iraq has hidden significant parts of its centrifuge program.

Brazil. Since 1978, Brazil has been pursuing centrifuges with limited success. Its program became known a few years after it started, and its successes have generally been announced or leaked to the Brazilian press.

■ **Calutrons.** In a large device called a "calutron," a strong magnetic field causes heavy and light uranium ions to follow trajectories with slightly different curvatures. Enriched uranium is collected and recovered in chemical processing buildings. The feed material is uranium tetrachloride.

Calutron facilities are expensive to build and operate, requiring a large labor force and massive amounts of electricity, making them relatively vulnerable, at least in theory, to outside detection. The chemical processing areas are one of the largest areas of a calutron facility. Here uranium is recovered from calutron parts and graphite collectors by scrubbing them with nitric acid, soaking them in acid baths, and burning or dissolving away disposable components.

The United States used calutrons to make the highly enriched uranium for the atomic bomb that destroyed Hiroshima. Because of its high costs, the United States abandoned the technology in favor of gaseous diffusion. But before the calutron buildings were finally closed in 1946, they processed a total of about one metric ton of weapon-grade uranium, using as feed the low-enriched uranium produced in the incomplete gaseous diffusion plant.

Calutron technology is considered easier to master than the other methods. In addition, most of the necessary technology has been declassified, although the art of making and operating calutrons is not widely available. Indicators of a calutron program include high power consumption, large heat discharges, a large staff for construction and operation, large chemical processing facilities, sophisticated high-energy power supplies, and many large high-vacuum pumps.

Iraq. The existence of Iraq's calutron program shocked the world. The West was caught by surprise when calutron research, development, and production facilities were found during the inspection process.

The Iraqis had made substantial progress toward the production of significant amounts of weapon-grade uranium at a site near Baghdad called Tarmiya. But they were encountering serious difficulties in finishing the plant; they would have needed a few more years to reach full-scale production of roughly enough weapon-grade uranium for one or two bombs every two years.

Iraq appears to have believed that it could keep its main production facility at Tarmiya hidden even after full-scale production began. It buried its major power lines and installed extensive filtration systems in the chemical processing buildings to reduce radioactive releases. Nevertheless, U.S. officials believe that the calutrons would have been detected once they were operating. The site was considered suspicious because it was remote and so large.

The calutron program was largely destroyed by the Gulf War and subsequent IAEA actions. Because this program is not easy to hide, the IAEA believes Iraq is unlikely to resurrect it.

■ **Aerodynamic separation.** This method separates uranium through the centrifugal effects of a fast flow of uranium hexafluoride gas in very small, curved-wall chambers. The method is even more energy intensive than gaseous diffusion.

Only South Africa and Germany have developed this technology. Brazil acquired a small, safeguarded aerodynamic plant from Germany, but it is abandoning the facility. The technology is not widely available, and there is little practical experience in monitoring its spread to other countries.

South Africa. The source of weapon-grade uranium for South Africa's nuclear weapons program was the aerodynamic process deployed at the Y-Plant at Valindaba. The plant was commissioned in 1974, began producing highly enriched uranium in 1978, and closed in early 1990.

Because South Africa has become a party to the NPT, it has had to declare its inventory of highly enriched uranium to the IAEA and agree to place all of its nuclear activities under IAEA safeguards. The IAEA has attempted to verify the accuracy of the declared inventory, particularly since the recent announcement by the South African government that it had built—and destroyed—six gun-type nuclear weapons.

Verifying the completeness and accuracy of South Africa's declaration is important, because South Africa is the first de facto nuclear weapon state that has placed its program under international inspection. This case will set important precedents for other countries, such as Argentina and Brazil, who have also agreed to apply safeguards on all their nuclear materials.

To help the IAEA, South Africa has provided the agency with extensive historical production information. But the information is insufficient to eliminate all discrepancies between the declaration and the IAEA estimate. A major problem is that a record of tails (waste) assays and amounts were either not kept or were recorded inaccurately. *World Inventory of Plutonium* estimates that the Y-Plant produced a total of from 200 to 525 kilograms of weapon-grade uranium.

■ **Chemical enrichment.** This method relies on the slight tendency of uranium 235 and 238 to concentrate in different molecules when uranium compounds are continuously brought into contact. Catalysts are used to speed the chemical exchange.

Both France and Japan have built pilot plants. The French Chemex method involves combining two immiscible uranium-bearing liquids in a tall column—an effect similar to shaking a bottle of oil and water. The Japanese Asahi process involves an aqueous liquid and a finely powdered resin through which the liquid is slowly percolated.

Chemical methods require more electricity than centrifuges, but considerably less than gaseous diffusion. Other indicators of such a program include large quantities of acid-resistant piping, pumps, and vessels, specialized resins and catalysts, and a large inventory of natural uranium. In addition, the Chemex method is characterized by tall buildings.

Iraq. Iraq declared its chemical enrichment activities in 1991. Iraqi officials stated that they were pursuing laboratory-scale work similar to the French and Japanese methods. Iraq obtained encouraging results in these experiments and was planning a pilot plant.

No evidence has been found that Iraq planned to produce weapon grade uranium through chemical enrichment. Documents seized by inspectors, however, show that Iraq was studying the production of 6 and 8 percent enriched uranium through combining the French and Japanese methods and batch recycling. Because these enrichment levels are higher than needed for power reactors, Iraq is believed to have planned to take low-enriched uranium from a chemical enrichment plant and feed it into calutrons, dramatically boosting their output of weapon-grade uranium.

Illicit acquisitions

The need for facilities to produce fissile materials can be bypassed if a country can buy or steal fissile material—or even a complete nuclear device. Although these items are accounted for and heavily protected, this route to nuclear weapons has an obvious attraction to certain countries, as well as to criminal or terrorist groups.

With the breakup of the former Soviet Union, concern has grown that nuclear weapons or material could be stolen and sold on an international black market. Although Russia and the former Soviet republics maintain that no weapons or fissile materials are missing, low-enriched uranium, milligram-quantity samples of plutonium, and radioactive sources have appeared for sale in Western Europe.

Another concern is the growing supply of civilian plutonium now in international commerce. *World Inventory of Plutonium* estimates that if current plans are realized, about 190,000 kilograms of plutonium will be separated during the 1990s. The separated plutonium will be shipped to fuel fabrication plants, turned into fuel, and then sent to power reactors for irradiation. Many of these shipments will cross international boundaries.

Lacking access to separated fissile material, a country might try to obtain nuclear waste containing small quantities of fissile material. Once it had such material, the country could build the necessary recovery facilities, bypassing several difficult production steps. Depending on the type of waste, hundreds or thousands of waste containers might be necessary to obtain enough material for a nuclear weapon.

There could be few indications of a successful theft or purchase of either fissile material or a weapon. Accounting at facilities that handle large quantities of fissile material may not be precise enough to detect the diversion of a few kilograms—or a few nuclear weapons. Western officials also worry that the former Soviet states might not admit a successful theft or diversion in order to avoid political embarrassment.

The only indications of such a diversion might be the emergence of a weaponization program. Additional indicators that a country has illicitly acquired a nuclear device or managed to build one out of purloined fissile material include the modification of aircraft for nuclear delivery, changes in command-and-control systems, and unusual security at suspected storage sites.

Iraq and the Italian smuggling ring. According to evidence offered during a 1984 prosecution, a ring of Italian smugglers offered to sell senior Iraqi military personnel 34 kilograms of plutonium that it purportedly possessed. After members of the ring and Iraqi military officials exchanged cables and had several meetings in Rome and Baghdad, the deal collapsed because the smugglers were unable to produce samples. The offer was undoubtedly a hoax, possibly intended to lure the Iraqis into buying conventional weapons.

The former Soviet Union. There have been recurring rumors about international uranium smuggling or black-marketeering in Europe of material stolen from the former Soviet Union or Eastern Europe. There have been reports of attempts to sell small quantities of depleted, natural, and low-enriched uranium for grossly inflated sums of money.[2] On March 5, 1992, two Russian men arrested in Augsburg, Germany, were carrying slightly over one kilogram of 2.8 percent uranium. They allegedly wanted to sell the material for over $1 million. Its actual value was estimated at about $350.

Similarly, minute quantities of plutonium have been found in Europe. In one case, according to the IAEA, a sealed plutonium source was seized by Italian customs officials at the Rome airport from a passenger who set off a metal detector. The sealed source was marked with the emblem Techsnabexport (USSR). Consultations with Russian authorities revealed that the sealed source—a standard calibration source sold by Techsnabexport—contained less than one milligram of plutonium.

Iran. There have been several reports claiming that Iran acquired two nuclear weapons from the former Soviet Union. U.S. and Russian officials have been unable to confirm these stories and several U.S. officials regard the information as unreliable.

Pakistan. China is reported to have supplied Pakistan with enough weapon-grade uranium for two nuclear weapons. The reporter who originally described this transaction was given the information by a Western intelligence official.

Weaponization

The acquisition of fissile material is only one part of making a nuclear weapon. There are several additional steps.

A nuclear weapons team must be assembled and managed in secret. The team must be able to master several technical areas, including theoretical calculations; high-explosive lens and main-charge development; high-speed testing capabilities; fissile material metallurgy; neutron initiator development and testing; arming, fuzing, and firing systems; and environmental testing.

If a full-scale nuclear test is not practical, the team must rigorously calculate and test the reliability and predictability of the device. One way to do that is through the use of a proven design—acquired elsewhere. But it is also possible to conduct additional research and non-nuclear testing.

> **The best results have been obtained when intelligence information is combined with on-site inspections of suspected sites.**

Many of these activities would be difficult or impossible to detect outside the program. But two indicators of a weaponization program are extensive high-explosive testing and the production or evidence of neutron initiator materials such as polonium 210 or tritium. Export monitoring might reveal a secret program if it showed that a country was trying to acquire special testing and diagnostic equipment, certain types of machining and inspection equipment, and high-speed electronic components.

Pakistan. U.S. officials have said on many occasions since the early 1980s that Pakistan got a proven weapon design from China. Little is known about this particular design, although it is likely to have utilized a nearly solid sphere of fissile material with a tiny hollow core for the neutron initiator surrounded by a tamper and high explosives.

Pakistan has said that it has all the components needed to assemble at least one nuclear weapon. This implies that Pakistan made weapon-grade uranium metal components for the core.

Pakistan has also conducted a large number of non-nuclear high-explosive tests. One U.S. official said that some of the tests were done in a horizontal shaft in a remote area of Pakistan.

Iraq. Before the Gulf War, Iraq had a broad program evaluating all the major areas of design, testing, and construction of a uranium core implosion weapon. Most of its research activities were conducted at the Al Tuwaitha nuclear research center. It was building a number of specialized facilities at Al Atheer where, it is now believed, weapons components were to have been built and tested.

Little of this program was known before the Gulf War. Al Atheer was only lightly bombed during the war while nearby missile development sites were heavily damaged. Many of the details about the weaponization program were revealed by some progress reports IAEA inspectors seized after the war. The inspectors say the program was at an early stage and a practical design had not been achieved. A number of problems remained to be solved, including the neutron-initiator design and high-explosives development. Iraq was, however, making polonium 210 for neutron-initiator research at its safeguarded Soviet-supplied research reactor. Target material made from bismuth was irradiated for about 15 days, then processed to recover the polonium. IAEA safeguards do not monitor for polonium. If safeguards had been thorough enough to detect polonium 210 production, Iraq's program might have been forced to use more difficult neutron-initiator designs. This could have delayed its weapons program significantly.

India. India has been capable of building nuclear weapons since at least 1974, when it tested a plutonium-core fission bomb in the Rajastan desert. Little is known about India's weaponization program, although most of it is believed to have been conducted at the Bhabha Atomic Research Center.

There is some controversy over whether India has built plutonium cores or "pits." Senior Indian atomic energy officials have said that India has not made pits, but Pakistan claims to have done so with weapon-grade uranium, increasing suspicions that India may have built pits in response.

Nonproliferation prescription

A surprising number of secret, small-scale programs and facilities have been detected before enough fissile material was produced or nuclear weapons successfully built. The best results have been obtained when intelligence information is combined with on-site inspection of suspected sites.

Clandestine programs have tended not to depend on safeguarded facilities, confirming the value of IAEA safeguards as a deterrent. Iraq and North Korea, however, have shown that safeguarded facilities can play an important role in the early stages of a plutonium separation program or in the production of radioactive materials for neutron initiators.

Most secret programs have not depended on illicitly acquiring separated plutonium, highly enriched uranium, or nuclear devices. Instead, they have aimed at developing an indigenous capability to make nuclear weapons. This could change if the former Soviet Union remains unstable, or if large amounts of separated plutonium enter international commerce.

Indigenous plutonium production and separation activities have generally offered enough clues to detect the accumulation of enough material for a bomb. Remote measurements of the heat output of a reactor can provide an indication of the amount of plutonium it has produced. But such techniques are of limited accuracy. There are no remote, reliable technical indicators of the total amount of plutonium separated at a small reprocessing facility.

Unsafeguarded enrichment programs have proven harder to detect. As expected, indigenously developed enrichment programs are more diffi-

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cult to identify, particularly in their research, development, and construction phases. There are few, if any, external indicators of the amount of highly enriched uranium a plant has produced.

Weaponization activities, which can be done at small, scattered sites, are often poorly understood and difficult to detect. Deployment of nuclear weapons, accompanied by high security and specialized military procedures, might be easier to recognize.

Aggressive export monitoring, with the cooperation of the business community, can be particularly useful in detecting secret activities. Scrutiny of exports has revealed centrifuge and weaponization activities that might otherwise have been difficult to detect. Almost all countries have sought foreign assistance to bypass indigenous development or shorten the time to obtain an essential capability. Weapons programs in the developing world have depended on the import of equipment, materials, or components. These countries' programs are particularly vulnerable to disruption through export controls.

Stringent export controls have slowed nuclear weapons efforts, and bought time for political approaches to work. By denying modern computerized manufacturing equipment, for example, export controls can force clandestine programs to rely on less sophisticated machine tools. These machine tools usually produce items more slowly and require more skillful operators, who are often in short supply in developing nations.

But export controls are not a panacea. A determined country with adequate resources can mount an effort to defeat or bypass export controls. Because technology is spreading worldwide, export monitoring may eventually become less effective.

Continued cooperation between intelligence agencies and international inspection organizations should make it harder for countries to hide their programs in the future. A successful nonproliferation regime will depend on governments maintaining a high level of political commitment, aimed in part at compiling and sharing complete and precise information about secret weapons activities. This type of nuclear intelligence gathering can involve multiple agencies and governments, some of which might be embarrassed by the exposure of a piece of information. Without sufficient commitment, governments may find it easy to overlook or ignore vital information. Lack of precise information can compromise the effectiveness of export controls and undermine economic and diplomatic initiatives.

Additional resources are needed if secret nuclear programs are to be detected. Governments need to implement more aggressive export monitoring and control and to share their findings with other governments. They also need to conduct more research on sophisticated detection techniques. Two areas that need more development are thermal monitoring of small heat sources and ways to detect underground facilities.

The IAEA needs to continue to develop more intrusive inspections. It has requested unofficial "visits" to undeclared sites and has resurrected its right to conduct "special inspections" of undeclared facilities in NPT states with safeguards agreements. These efforts need to be bolstered, including the development of procedures to inspect both declared and undeclared sites quickly and effectively.

The IAEA should safeguard more nuclear materials. It has taken a step in this direction by inviting member countries to submit more information on nuclear materials, such as uranium concentrate, or "yellowcake." But the IAEA needs to apply safeguards to yellowcake, and to nuclear materials such as tritium and polonium 210, that are key to the development of neutron initiators.

The IAEA needs to expand its inspection of dual-use equipment beyond Iraq. It has already invited a number of member states to provide information on exports and imports of nuclear and dual-use equipment for a new registry.

Beyond these incremental improvements, a new climate of openness and transparency is required. It should be harder for countries to hide nuclear programs in the first place.

Since the beginning of the nuclear era, access to information about nuclear programs has been a matter of great sensitivity in both nuclear weapon programs and in nuclear commerce. But the main reasons for secrecy among the nuclear powers are disappearing; in fact, they are becoming counterproductive. Deep reductions in the U.S. and Russian nuclear arsenals are now proceeding. Under the reduction plans, hundreds of tons of fissile material are scheduled to be removed from the arsenals. Openness would help to build confidence that these materials are not misused. Excessive secrecy no longer serves commercial interests—in fact, it has fed public mistrust.

A first step toward a more transparent international system would be for all nations to declare their stocks and production sites of plutonium and highly enriched uranium. Fifty years after the beginning of the nuclear era, the world can no longer accept that the data about these dangerous materials are not available. ■

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RUSSIA'S "RED-BROWN" HAWKS

By VITALII I. GOLDANSKII

Soviet nuclear specialists rail at vanishing funds and prestige; neo-fascist groups want arms and power—and a new Cold War.

Since the beginning of the "Gorbachev years," there has been a remarkable democratization in Russia, but there has also been a sharpening of internal contradictions. These years have led to a coalition of "red-brown" groups—the most reactionary elements of society—Stalinists, extremely aggressive members of the military-industrial complex, self-styled "protectors of the Russian Empire," national patriotic unions, and groups with their own storm troops (who are, in fact, neo-Nazis). These have also been years of economic decline and the withering of research in the fundamental sciences.

In the early summer of 1990, when the conflict between Mikhail Gorbachev and Boris Yeltsin was revealed, it greatly revitalized the activities of military officials and nuclear scientists closely connected with the military-industrial complex. Some military circles had continued to think seriously about nuclear war even during the Gorbachev years. Just as a Bundeswehr investigating team found plans in the East German archives for a Warsaw Pact attack on Central Europe involving tactical nuclear weapons, similar plans were made even after the Warsaw Pact's May 29, 1987, "Berlin Declaration" that called for abandoning the "enemy image" and reliance on force.[1] (The Eastern strategists planned to reach the English Channel in two weeks, the Mediterranean Sea in four.)

Shortly before the August 1991 coup, Soviet nuclear scientists began to air their complaints in public. In an interview in the June 26, 1991, *Komsolskaya Pravda*, Yevgeni Avrorin, the scientific director of Chelyabinsk-70, said: "In all likelihood, at the present time we are taking our first steps toward World War III. Peace can only be preserved by keeping superpower parity. Yet we [the Soviet Union] are disarming. Most initiatives made in the last years, such as a one-sided moratorium on nuclear tests and a reduction of the financing for defense sciences, are simply unilateral disarmament obscured by loud rhetoric."

Boris Litvinov told *Komsolskaya Pravda*: "Maybe we need to decrease our nuclear arsenals and tanks, the production of which has been excessive. Then, instead of hundreds of existing units, we scientists must design a single new warhead that will allow us to maintain parity. The government is not giving us such an opportunity."

And Professor Vladimir Nechay, director of the Research Institute of Technical Physics (Chelyabinsk-70), told the notorious *Den* ("The Day"): "Nuclear weapons are designed to destroy military objects first. It is not necessary to destroy New York or Moscow. Missile silos, military bases, and command posts will be hit first. . . . If it costs a hundred explosions . . . nothing terrible will happen. I think that our half-schooled ecologists have caused more harm to the people's health than all the nuclear tests carried out in the country together."

But on August 8, 1991, Academician Yuli Khariton, scientific director of the Research Institute of Experimental Physics (Arzamas-16)—and the remaining patriarch of Soviet nuclear weapons—told *Izvestia*: "On July 30 and August 2 the Leningrad TV station aired the program *Panopticum* ("600 Seconds"), which covered our defense industry, highlighting the classified research town of Arzamas-16, where I work. The authors of this program, Col. Nikolai Petrushenko, a Peoples' Deputy, and TV anchor Alexander Nevzorov, whom I did not know before, dishonestly used my name for their own political purposes: to stir up mistrust toward the new START Treaty . . . and to attack the Soviet leadership's policy as tantamount to treason. I strongly object to such a position."

Khariton wrote of the necessity and unavoidability of cutting the military budget while international conditions were radically changing and the country was experiencing a deep economic crisis. But he also stressed the necessity of preserving such unique scientific and design collectives as Arzamas-16 and Chelyabinsk-70.

The identification of the U.S.-Soviet nuclear weapons reduction treaties as high treason, along with policy statements issued by the leaders of the August coup, were ominous. During the coup, a statement on the renewal of the Cold War was prepared by the Ministry of Foreign Affairs, but it was never issued. The coup leaders did issue another diplomatic document, one that informed Saddam Hussein of their desire to "restore" the Soviet Union to its position as a counterweight to U.S. influence in the Middle East. The junta's letter to Saddam Hussein was repudiated immediately after the legitimate government was restored.

The loss of nuclear science and technology's prestige can be illustrated through the example of the Mos-

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cow Institute of Engineering and Physics, whose mission was altered in 1943 to prepare specialists for the creation of Soviet nuclear weapons. Among the founders of this institute were Igor Kurchatov, Yakov Zeldovich, Isaak Kikoin, Lev Arzimovich, and other outstanding Soviet nuclear scientists. This institute belonged to the Atomic Ministry. Joining this very privileged institution was extremely difficult; not only were there stringent rules covering an applicant's biographical particulars, there were also up to 20 applicants for each vacancy. In recent years, applications have fallen to less than one per vacancy. In 1991, the best students selected by the capital of the non-official "Nuclear Archipelago," Arzamas-16, refused to go there.

When they eliminated the American nuclear monopoly, Soviet nuclear arms specialists were cast as saviors of the world and saviors of the Socialist Motherland. Now, especially after Chernobyl, with the difference between "peaceful" and "military" atomic energy shrinking in the minds of millions, nuclear scientists, as well as chemists, are viewed as if they were poisoners of our planet, capable of killing nature—plants, animals, and even people—merely to satisfy their self-interest. Moreover, stories have been emerging in which KGB intelligence officers are trying by any means to disparage the scientific merits of Soviet scientists, and to persuade the public that the most important work on Soviet nuclear weapons was performed by the KGB officers who obtained information through espionage.

The early nuclear specialists also received many government awards—Hero Stars, Orders, Lenin and Government Prizes, high salaries, high-quality medical care, food, and goods. To some extent, all these rewards compensated for the impossibility of traveling abroad, for life behind barbed wire, and for the tough regime.

Today all the advantages of living and working in nuclear arms centers are gone—except for the availability of superb high-tech equipment and computers, an advantage that cannot be found in the "civil sciences."

In part to prevent the flight of Russian nuclear specialists, the U.S. Congress appropriated about $400 million for the dismantling of Soviet nuclear weapons. In addition, an initiative by three foreign ministers—Andrei Kozyrev of Russia, Hans-Dietrich Genscher of Germany, and James Baker of the United States—led to plans for a center in Moscow designed to open up new opportunities for Russian scientists, to prevent their emigration, and to become a laboratory for the development of new technologies.

Because hundreds of millions of dollars have been set aside for very specific purposes, the question of their proper distribution has arisen; many believe that the funds should be disbursed only to people who are directly involved in weapons dismantling, not given to those who work in related areas. According to some arms specialists, "the physicists from Dubna and the Kurchatov Institute know no more about nuclear weapons than is written in any textbook."

According to Pavel Felgenhower, the new Moscow science center will "help some Soviet scientists financially, but it won't prevent the proliferation of nuclear weapons. On the contrary, it will most likely stimulate the emigration of true military nuclear specialists."[2]

The problem of a "brain-drain" in the nuclear sciences was downplayed by Minister of Atomic Power Victor Mikhailov in November, 1991: "So far not a single qualified nuclear scientist or nuclear weapons designer knowing important information has left the country. With confidence, I can say that my colleagues are patriots and won't leave the country to design nuclear weapons for anyone."[3]

Let us hope that Mikhailov is right, and that patriotism will play a positive role in preventing the flight of nuclear specialists. But at the same time we should keep in mind that the so-called "national patriots," including members of the neo-Nazi society *Pamyat*, consider the United States and Israel to be Russia's main enemies and Saddam Hussein and Muammar Khadafi its best friends and closest allies. As *Nezavisimaya Gazeta* pointed out, *Pamyat* is very active in Arzamas-16. Most members are mathematicians, inspired by strongly anti-semitic colleagues like Igor Shefarevich, but some are physicists. Some of them might be willing to design an "Arab bomb"—especially if they were paid good salaries in hard currency.

In contrast to Russian denials of a "nuclear exodus," German Federal Intelligence (the "BND") claims to have extensive files on the recruitment of Russian and other Eastern experts by Third World countries. According to the BND, several scientists are reported to have signed an agreement with Algeria. Four others offered their services to India. Fifty specialists, including one from Arzamas-16 and a missile specialist from Ukraine, currently live in Iraq. Fourteen atomic specialists have been residing in Iran since 1991, and new work agreements with Teheran have been signed by 50 engineers and 200 technicians. Two Russian specialists received offers from Libya, but many Russians were already involved in a number of non-official nuclear projects there. Last but not least, among the 7,000 scientists that have immigrated to Israel since 1989, 40 are atomic specialists.[4]

In order to stop the "nuclear exodus," a second international scientific center was to be created, to deal with employment problems within nuclear manufacturing. This venture was supposed to be supported by the European Community, but the center's construction appears to be moving slowly.

Within a year or two, the United States and Russia will sign an agreement on the purchase by the U.S. Energy Department of enriched uranium from dismantled Russian weapons.

The Americans tried to obtain from Russia all documents related to the export of uranium, not only to the United States, but to other countries, as well as documents on uranium enrichment. By Russian demand, the market price of uranium at any point in time will be announced by the U.S. Commerce Department only after consulting with the Russian Ministry of Atomic Energy. This Russian-American agreement is an example of agreements that stimulate the peaceful applications of atomic energy, encourage nuclear weapons dismantling, and prevent nuclear proliferation.

Other arrangements may be less benign. There are many rumors about the illegal export of nuclear weapons, especially from Kazakhstan to Iran. In March 1992, the BND said that Iran had purchased two nuclear warheads from Kazakhstan.[5]

Citing U.S. intelligence as its source, on March 15, 1992, the Russian TV program *Vesti* ("News") reported that three air-launched missiles with nuclear warheads had been stolen from Kazakhstan, and that two of these warheads had been purchased by Iran. This story was categorically denied by the head of CIS military forces, who said that no tactical weapons remained on Kazakh territory in March 1992. Kazakh leaders also denied the rumor. During an official visit to Israel, Sergey Tereshchenko, the Kazakh prime minister, announced that his country was not planning to sell the nuclear weapons it inherited from the Soviet Union. Nevertheless, rumors continue to spread about a Kazakh-Iranian accord. Kazakhstan is now releasing previously classified information on the size and characteristics of its uranium deposits.

Nuclear specialists from both sides have not yet laid aside their mutual mistrust. Yuri Trutnev, who gave Yeltsin the idea of retargeting Soviet missiles away from American cities, has bitterly noted that "American missiles are still pointed at our side."[6] Yevgeni Negin said, "Everyone is talking about disarming. But I am sure that the Americans don't even think about real disarming."[7]

At a January 14, 1992, meeting of the presidium of the Russian Academy of Sciences, Evgeni Avrorin suggested: "The question of whether Soviet nuclear weapons specialists run to Khadafi, Hussein, or any other aggressor is widely discussed in the Western press. To prevent this from happening, support for the work and the standard of living of scientists—not just tips—is needed."

It may seem ungrateful, but it is necessary to play the Cassandra role when forecasting Russia's future. The victory for democracy in August 1991 now seems to be irrevocably past. In enjoying their victory, the democrats failed to follow the advice of journalist Walter Laqueur: "This is no time to be generous to anti-democrats."[8] Instead of taking drastic measures against reactionary forces, the democrats began settling petty scores among themselves.

The situation in Moscow as well as the rest of the country is now characterized by massive demonstrations against economic disaster, hyperinflation, the failure of the government to keep its promises, and escalating crime, corruption, long queues—and high prices, which were previously unheard of. Armed groups of "national patriots" have been preparing to take action, and they recently attacked Moscow's most popular democratic newspaper, the *Moskovski Komsomolets*. The real civil war, with hundreds of thousands of victims, has been escalating in Tajikistan, the Northern Caucasus, between Georgia and Abkhazia, between Armenia and Azerbaijan, and between Moldova and Pridnestrovie. Cossacks are taking power in many areas, from the Don and Kuban to Priamurie.

Recently the Russian National Rescue Front, the most reactionary and fascist Russian organization, held a conference in one of Moscow's largest halls. The front is led by TV anchor Alexander Nevzorov, a sort of Russian version of Patrick Buchanan; right-extremist newspaper editor Alexander Prokhanov; and others, including KGB Gen. Alexander Sterligov. Defense Minister Gen. Pavel Grachev's statement in support of the government didn't slow the extremists, and a breakdown in the army, if it occurs, will only complicate the situation in the country.

There is likely to be a significant reorganization of the government, which may require making an unstable peace with the right-wing coalition. In the best outcome, power would pass to a coalition of small centrist groups and the much-weakened democratic reform movement led by Gavriil Popov, the former mayor of Moscow. The centrist groups are currently led by Arkady Volsky, the leader of Civic Union, Alexander Rutskoi, the vice president, and Nikolai Trankin, a former Supreme Soviet member. This coalition should lead neither to significant changes in Russian foreign policy nor in economic relations with other countries, nor in deviations from the current policy on nuclear disarmament. Nevertheless, the military-industrial complex would play a more important role in the future—mainly, it is hoped, to solve the problems of conversion.

A completely different forecast should be made if the Russian National Rescue Front comes to power. The group's theoreticians believe in the idea of a global confrontation between the forces of Orthodoxy and Islam on the one side and Catholicism and Judaism on the other. The United States, Japan, and China would be considered Russia's strategic enemies. Nuclear disarmament would become unpatriotic, and the continuation of nuclear testing would be a vital task. The Russian National Rescue Front's foreign policy constitutes the real Cold War. The world community should remember this well, and base its future relations with Russia and CIS on that knowledge. Only a democratic Russia has the right to obtain political support and economic help from the Western democracies. ■

Vitalii I. Goldanskii is a scholar at the Semenov Institute of Chemical Physics, Moscow.

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EUROPE'S LEAKY BORDERS

By HARALD MÜLLER

Europe's erratic export control policies have led to critical technology and material slipping across borders to nuclear wannabees.

Europe is a powerhouse of industrial and technological achievement. It is a continent where integration is coinciding with the disintegration of old systems of control over national policies and economic activities, and where new market structures are growing rapidly. These dynamic developments harbor great opportunity for shaping more coordinated nonproliferation policies. At the same time, there are distinct dangers that the confluence of these developments could ease the acquisition of critical materials, equipment, and technologies by proliferators outside of Europe.

So far, the Western European nuclear export record has been dismal. Israel received reactor and reprocessing technology, as well as weapons information, from France; heavy water from Norway; and huge amounts of natural uranium from Germany and Belgium. Pakistan acquired enrichment technology from the Netherlands and Belgium, and a panoply of other commodities from all over Europe, particularly from Germany. India got heavy-water technology from Germany and other important assistance from France and Belgium. South Africa profited mainly from Germany, but also from Britain and France. Brazil was helped by Germany and the Netherlands; Argentina by Germany, Italy, and Switzerland; and Iraq again by all—with Germany in the lead.

Even North Korea is now reported to have received critical material from East German companies. In other words, wherever nuclear aspirants have emerged in the last three decades, they have had the conscious or unwitting assistance of Europe. The sheer number of cases proves clearly that national export control systems have been vastly deficient. Inter-European efforts to identify critical cases early and to prevent undesirable transfers have failed. And behind the failure of licensing and custom agencies has been a neglect of the whole area by political leaders, and the choice of commerce over nonproliferation policies.

The relative neglect of export controls has been reflected in export philosophies. The 1970s and 1980s were characterized by a fierce debate about the suitable recipients of exports. Some states argued that exports should be approved only if recipient states were subject to "full-scope safeguards"—in other words, that all their nuclear material was safeguarded by the International Atomic Energy Agency (IAEA). In contrast, some states maintained that exports were permissible if only the items that were being transferred were going to be safeguarded ("item safeguards"). The United States, Canada, Australia, and Sweden, supported by such European countries as the Netherlands, Ireland, and Denmark, argued for full-scope safeguards. But the majority of European exporters, led by Germany, France, Switzerland, and Belgium made deals based on item-safeguards policies. As a conse-

quence, countries conducting non-safeguarded activities—Pakistan, India, Brazil, Argentina, and South Africa—could enjoy an extensive nuclear trade without having to join the Nuclear Non-Proliferation Treaty (NPT).

But in the late 1980s, a landmark change took place, introduced by a series of reforms in German export law. Several export scandals attracted international criticism and provoked serious domestic debate; finally they shocked the government into action. In contrast to the prevailing U.S. perception, this process started somewhat before U.S. criticism of German participation in Muammar Khadafi's chemical weapons program; but the "Rabta affair" helped to accelerate the speed of the reform process.

Then, German unification brought an awareness of "new responsibility." The political elite came to believe that the new Germany could not afford a "merchants of death" reputation. From 1988 on, a series of changes in laws, regulations, and implementation tightened the German export control system.

In summer 1990, Germany finally announced that it would follow a full-scope safeguards export policy. Within less than a year, the rest of the European Community (EC) and Switzerland had followed the German example, and export control laws were revamped in several European states.

At the same time, high-level attention to nuclear proliferation rose visibly. In July 1990, the EC summit of heads of state and governments issued its first declaration on nonproliferation, including an endorsement of the NPT. A year later, the EC agreed on a common framework to guide decisions on arms and dual-use exports, including a review of the credentials of recipient countries. The members also proposed strengthening IAEA safeguards, and they coordinated their positions within the Nuclear Suppliers Group. The change was most visible when, in April 1992, the Suppliers Group adopted the "Statement on Full-Scope Safeguards," built largely on the EC draft. Who would have believed in 1989 that Western Europe would—and could—take the lead on this issue?

This is a welcome development, but it does not eliminate all existing fears. EC members face a major problem as the creation of a single market approaches. Controls of strategic commodities are exempt from EC action under Article 223 of the Rome Treaty. General proliferation issues, on the other hand, are under the purview of European Political Cooperation (EPC), and the movement of fissile material is within EC authority. This confusion creates a lot of practical legal problems when defining what "political union" means with regard to export controls.

In addition, the ability to mount an effective control effort varies enormously among EC members. Some governments with efficient systems are very reluctant to abolish national controls for the sake of a single market, and they have based their argument on the "strategic commodity" exemption. They fear that sensitive commodities will travel through weak-control states and disappear to undesirable destinations. With a growing list of controlled commodities, this exemption would make a mockery of the single market.

But EC members have sought a way out of the dilemma; an EPC working group on nonproliferation has set up a committee to negotiate a uniform control list. Second, the Commission of the European Communities will help weaker members to set up more effective control systems. A uniform export list is only the first step. Harmonization of laws and regulations, and quality control for implementation are badly needed. Yet these steps touch on some of the most sensitive aspects of national sovereignty, and they will not be easily solved.

In the end, however, it is hard to see how one can avoid transferring some authority (on data collection and quality control) to the commission. The European Business Roundtable, an industry organization, has already proposed a uniform system lest trade and economic growth within the community be badly hampered. And as long as no solution is found, the risk that bad-willed exporters may set up front companies in the countries with the weakest control standards and the most limited penalties—or use those countries as transit stations—remains a serious risk.

The result of a 1991 survey of the 12 members' export control lists was somewhat surprising; nearly identical lists should have been found, because all EC countries nominally adhere to the London Guidelines and the Coordinating Committee for Multilateral Export (COCOM) nuclear list. But the survey showed striking divergences. Only the Irish list contained all 72 controlled items. The Netherlands, Britain, and Germany lacked one item each. In Italy, seven items were missing; in Denmark, eight. Important suppliers like France and Belgium had dangerously leaky lists, with 14 and 20 items missing, respectively. Spain, another country with considerable export potential, excluded a full third of the required items.

By fall 1992, however, the member states' item lists had been harmonized, and the drafting of harmonized country lists (countries to be excluded from nuclear and dual-use transfer, and countries to which transfers would be possible under facilitated licensing rules) was under way. The size of these lists, and particularly the question of publicizing them, is still contested.

Ultimately, the EC is expected to approve guidelines that are similar to recent German legislation. The community is moving toward an electronic data network and a regular process of review. However, there is still some lack of clarity concerning some nuclear goods covered by the Euratom Treaty. Because of more principled divergences on the respective role of the EC commission and the member states, and on the timing of the introduction of a common system, the December 1992 EC Council did not make a final decision. Meanwhile, it was agreed that intra-EC controls should continue, but that they must lose their character as primary border controls. This is a vague prescription that gives the member states broad leeway to continue with controls almost as before. But some EC guideline is likely to be adopted one day, and after a transition period of a year or so, licensing within the community would end.

There is little doubt that, as of the end of 1992, the countries of the European Community had given nuclear nonproliferation unprecedented priority; in fact, nonproliferation is listed as one of the priority areas of the common foreign and security policy for the Maastricht Treaty. Even if that treaty should fail, there is no doubt that nonproliferation will continue to range high on the common agenda. There are few other areas of concern where, starting from strong divergences in tradition and attitude, such a degree of consensus has been achieved. ■

Harald Müller is director of international programs at the Peace Research Institute in Frankfurt.

EUROPE'S NUCLEAR DOMINOS

By JANE SHARP

U.S. leadership in NATO is the best protection against nuclear proliferation in Europe.

As long as the United States continues to play a leading role in NATO, the incentive for European powers to acquire independent nuclear weapons is virtually zero. Nevertheless, most European powers, especially in the prosperous West, have relatively sophisticated nuclear establishments and could easily manufacture nuclear explosives if they judged that their security required an independent capability.

They might so judge if the United States pulls out of Europe and out of NATO. As the European response to the wars in the former Yugoslavia demonstrates, when the United States abdicates its leadership, the European allies are less likely to form a cohesive security alliance than they are to conduct their foreign and defense policies according to narrow national interests. If the United States withdraws, and if Britain and France insist on maintaining their current status as independent nuclear weapons powers, they will encourage proliferation by example. It is under these conditions that a new generation of German leaders might also want independent nuclear weapons. NATO, by de-nationalizing European defense policies, has been the preeminent vehicle for nonproliferation in Europe since World War II.

Over the next 50 years, Poland might also seek nuclear status if Germany acquires nuclear weapons and if Belarus and Ukraine do not give them up. Poland could also feel threatened if Germany remained nuclear-free but became closely allied with Russia, especially if Russia gave Kaliningrad (formerly Konigsberg) back to Germany. Poland does not, however, have any nuclear power plants at present—just a research reactor—so it could not proceed quickly with any nuclear ambitions.

Turkey is another state that has little nuclear expertise and appears not to have any nuclear ambitions in the short term. But its security could be easily destabilized by its neighbors' actions. At least four of its neighboring states are nuclear and three are near-nuclear: Israel is an undeclared but obvious nuclear-weapons power; Iran is close to being nuclear-weapon capable, and is reported to have bought or stolen three nuclear warheads from Kazakhstan; and Pakistan is also close to achieving nuclear-weapon capability. Russia is and will remain a nuclear-weapon state for the foreseeable future. Belarus, Ukraine and Kazakhstan control former Soviet strategic missiles for the time being. Their nuclear status will remain uncertain in all likelihood through the 1990s—or until their weapons are finally dismantled.

Without NATO's security guarantee, Turkey might find its neighbors sufficiently threatening to assert itself as a regional nuclear power, straddling the Balkans and central Asia. Should Turkey acquire nuclear weapons, Greece would certainly want extra reassurances from the United States or NATO which, if not forthcoming, might make Greece a candidate for proliferation. Serbia could also see itself at risk from a nuclear Turkey and would be able to look only to Russia for a security guarantee. Yugoslavia threatened to leave the Nuclear Non-Proliferation Treaty (NPT) regime at the 1975 review conference on the grounds that the nuclear powers were not living up to their part of the bargain. As the most aggressive, least trustworthy state in Europe, Serbia bears close watching as a potential proliferator, despite being a party to the NPT.

Armenia would certainly be unsettled by a Turkish bomb, given its history of enmity with Turkey. In September 1991, Armenian government spokesmen indicated an interest in signing the NPT, but the government has taken no action. Azerbaijan has signed the NPT, but it would not remain passive in the event Armenia went nuclear. It is not difficult to imagine the proliferation chain.

How secure?

As the Cold War wound down in the late 1980s, a number of alternative futures for Europe were proposed. Those who hankered after a stable bipolar world hoped for a "Cold Peace" in which a balance could be struck between the United States and its allies on the one hand, and a more democratic Russia and its allies on the other. Although this balance might have been stable, it would not necessarily have been equitable. Anyway, this scenario was a non-starter even before the collapse of the former Soviet Union, because relations between Moscow and the East European capitals deteriorated so badly during the Cold War years.

In the early 1990s, the newly independent East Europeans want to put the former Soviet Union behind them and move resolutely westward. This is proving difficult; sooner or later East Europeans will have to open trade links to the East to survive, because Western governments are simply not generous enough to open their markets; witness the French government's resistance to changing the Common Agricultural Policy of the European Community (EC). And East European governments do not yet appear ready to reopen serious relations with their former masters.

A second scenario posited a cooperative Europe and a weak Soviet Union (or Russia) in which the main centers of power would be the United States and a much deeper and wider European Community. Such a European Community would be deeper in the political sense, with common currencies, common defenses, and common foreign policy; wider in that the community would absorb the former communist countries when they became democratic and market-oriented.

This scenario assumed that when the Soviet threat faded in Europe, the principle of common or cooperative security would prevail. Some observers, especially in the former Warsaw Pact countries, put their faith in the pan-European Conference on Security and Cooperation in Europe (CSCE) as the best system to maintain peace. Others believed that the community of Western democracies, in which governments no longer thought of settling political disputes by force, would be a model for the former communist countries, and would encourage them to adopt pluralistic democracies and market economies. In effect, as they adopted Western values, they would be absorbed into the Western security community.

In this scenario, based on West Germany's record as a reliable partner in both NATO and the European Community, a united Germany was seen as a stabilizing factor in Europe.

A third scenario, a fragmented Europe, was the most pessimistic. Regrettably, it also seems the most likely. This scenario assumed a strong United States but a weak EC as well as a weak former Soviet Union. It predicted that the end of Cold War rivalry between East and West would release long-suppressed rivalries and ethnic hatreds in the East, and especially in southeastern Europe. The power and influence of a united Germany was expected to be much more difficult to contain in this kind of fragmented multipolar Europe.

In 1990, events seemed to favor a cooperative Europe as old Cold War structures, like NATO and the CSCE, began to establish new institutions to cope with the new environment. In 1991 and 1992, however, two developments seriously damaged prospects for cooperation and integration in Europe—the disintegration of the former Soviet Union and of Yugoslavia into their constituent republics, spawning some 20 new state entities, and the possibility of more to come. This proliferation of states blurred the geographical and political boundaries of Europe; now no one is certain where Europe ends and Asia begins.

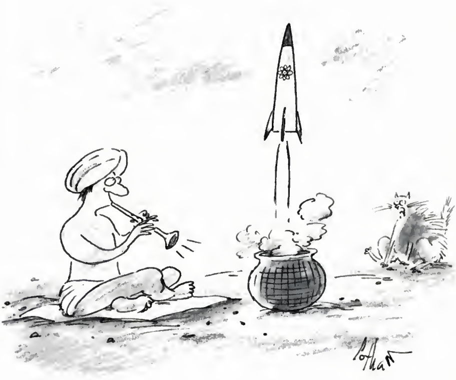
In 1990 it looked as if Western Europe might gradually absorb the five non-Soviet members of the Warsaw Pact, starting with the central European countries (Poland, Hungary, and Czechoslovakia), then Bulgaria and Romania. By late 1992, however, there were more than two dozen former communist countries claiming to be "European" and clamoring for membership in Western institutions. And worse, the wars in Yugoslavia displaced over two million people, mostly Muslims fleeing the savage ethnic cleansing of the Serbs and Croats.

Most West European governments could not cope with this flood of refugees and in some cases, literally closed their doors.

New strategy for NATO

Throughout the Cold War years, from the end of World War II in 1945 until the fall of the Berlin Wall in late 1989, the primary threat to the security of Western Europe was thought to be a direct military attack by the Soviet-led Warsaw Pact. Accordingly, the diplomatic and military energies of the Western democracies were devoted to building forces and institutions to deter, to meet, and, through arms control negotiations and détente, to reduce the threat.

The first secretary general of NATO, Lord Ismay, used to say that NATO served three purposes for Western Europe: it kept the Americans in, the Russians out, and the



Germans down. By late 1991, after the Warsaw Pact had collapsed and the Soviet Union had devolved into its constituent republics, some observers questioned whether NATO was still needed.

But in late 1992, most policy-makers agreed that Lord Ismay's threefold rationale remained valid. Even though Russian intentions toward the West now seem benign, both its nuclear and non-nuclear forces present serious challenges, and the threats and challenges that might be posed by Belarus, Ukraine, and Kazakhstan remain uncertain. In addition, the unification of Germany threatens to destabilize Europe (not militarily so much as politically and economically) and both halves of Europe (and especially the current leadership in Germany) want Germany deeply embedded in Western democratic institutions, primarily the EC and NATO. Finally, although West Europeans disagree on many aspects of security, they all agree that the United States should maintain a military presence in Europe, for which NATO is the best framework.

But to remain viable, NATO, including France, must adapt to the new multipolar Europe. Some claim the best way to do this is by streamlining NATO forces while maintaining the collective defenses of the 16 member states as a bastion of stability. My own view is that NATO should become an instrument of collective security for the whole of Europe, both by taking in new members as they meet Western standards of democracy, and by offering security guarantees to the smaller European states.

From the fall of the Berlin Wall until November 1991, NATO undertook a two-year strategy review. The allies settled on four goals. They wanted to streamline NATO's structure, based on a much-reduced threat from the former Soviet Union, and at the same time increase its flexibility to meet unforeseen challenges. They also wanted to maintain an integrated approach to planning and thus avoid re-nationalization of defense policies (especially German defense policies), and to maintain a U.S. commitment to European security.

The most controversial aspect of the review was the decision to create an Alliance Rapid Reaction Corps (ARRC) under British command. The Germans felt that their contribution to NATO entitled them to a bigger slice of command; the French saw the ARRC as undermining their goal of a European corps. But the Anglo-American view prevailed. Less controversial was the decision to drastically cut NATO's nuclear forces, a move taken, in part, to encourage similar cuts by the former Soviet leadership while it still controlled its huge nuclear arsenal.

When announcing its new strategy in November 1991, NATO claimed four core functions. It would provide one of the foundations of European stability, serve as a forum for transatlantic political consultations, deter and defend against attacks on member states, and preserve the strategic balance in Europe. There was, however, no decision to extend NATO operations beyond the defense of the territories of the 16 member states, and thus no mandate to intervene in the kind of conflict raging in the former Yugoslavia, except that individual NATO states could continue to contribute forces to U.N. peacekeeping operations.

Widening NATO?

Even before the Warsaw Pact collapsed, several former Warsaw Pact states, including Russia, announced that membership in NATO was a long-term goal. Poland, Hungary, and Czechoslovakia were the most persistent aspirants. Brussels' consistent response, however, has been cool. Visiting NATO headquarters in October 1992, Hanna Suchocka, the Polish Prime Minister, said she was convinced "we shall obtain full membership to NATO." But Manfred Wörner, Secretary General of NATO, would only say that if NATO decided to take new members, Poland would be one of the first applicants. Previously, however, NATO ministers had invited all the former Warsaw Pact allies, including all the former Soviet republics, to join the 16 NATO states in a North Atlantic Cooperation Council (NACC).

The NACC was established in December 1991 to curb the appetites of former communist countries for full NATO membership and to rationalize the Western powers' involvement in the reorganization of the former Soviet military forces in the newly independent republics. (The Western powers were especially eager to establish a forum that would permit them to oversee nuclear planning in the former Soviet Union.) In its declaration of intent, NATO emphasized benefits for the former Warsaw Pact powers, promising consultation and cooperation on security issues that included defense planning, arms control concepts, civil-military relations, air-traffic coordination, and military-to-civilian manufacturing conversion.

The NACC's first accomplishments were mixed. Based on their associate membership status in the European Community, the leaders of Poland, Hungary, and Czechoslovakia had hoped for preferential treatment by NATO on grounds that they were closer to achieving Western-style democracies than their former Warsaw Pact partners. However, NATO chose not to differentiate between the former communist states, which included all the Asian republics of the former Soviet Union.

If Britain and France ever renounce their independent nuclear arsenals, the NACC could be a useful vehicle through which the Western powers could demand that the three non-Russian independent republics with nuclear weapons give them up, arguing that a proliferation of nuclear weapons powers in Europe was unacceptable. But as long as France and Britain insist on keeping their own nuclear weapons, they undermine the NACC's leverage.

The CSCE

From 1972 until 1990, the 35 member states of the Conference on Cooperation and Security in Europe (CSCE) met to discuss three groups of issues: military confidence and security building measures (CSBMs), economic and technical cooperation, and human rights. For 18 years the 35 met without any formal institutions, although CSCE provided neutral ground for the two blocs to interact. The irony is that, in the post–Cold War period, with the barriers down between the old bloc structures, the CSCE has been almost totally ineffectual. In the Cold War years the Warsaw Pact states were able to use the CSCE as a forum to chastise their own governments' dismal human rights records. But on crucial minority rights problems, the CSCE has proved feeble. This has not gone unnoticed by Muslim states.

Not only for altruistic reasons but for hard-nosed strategic and security considerations, it is vitally important for Western states to pursue minority rights legislation throughout Europe in the coming decades. Otherwise the former communist countries will suspect—and they may be right—that Western governments pursued minority rights in the East during the 1970s and 1980s only as a means to undercut Soviet control over its European satellites.

At a summit meeting in November 1990, CSCE produced a new charter and several new structures, including a permanent secretariat in Prague, a Conflict Prevention Center in Vienna, and a human rights office in Warsaw. All three institutions were grossly under-funded. This was largely because the United States and Britain did not want any CSCE structures strong enough to compete with NATO in managing European security. The irony is that NATO proved just as impotent as the CSCE in the Balkans. To the extent that any international organization tried to deal with the wars in the former Yugoslavia, it was the United Nations and the EC, both of which were undermined by the reluctance of any government to offer responsible leadership.

The atmosphere of the July and December 1992 CSCE summit meetings in Helsinki and Stockholm was bleak. As many leaders noted, even though the Cold War was over and much cooperative pan-European diplomacy was under way, Europe remained divided. The West is a security community composed of NATO's member states, the European Community (EC), the European Free Trade Association, and the Western European Union. Among these groups, the trend is toward integration and cooperation, albeit with setbacks. In the East are the former communist states of Eastern Europe and the former Soviet Union, where disintegration and conflict reign.

Beefing up CSCE

The new institutions and mechanisms established at the Helsinki summit were designed to beef up woefully inadequate CSCE structures. To establish continuity and make the Council of Foreign Ministers more efficient, an executive troika, modeled on that of the EC, was established. The troika includes the immediate past president of the CSCE, the current president, and the president-elect. Skeptics noted that because CSCE is arranged alphabetically in English, the troika could go through some lean leadership periods—for example when Malta, Moldova, and Monaco are in charge.

To improve chances that potential conflicts can be investigated before they erupt, a new High Commissioner on National Minorities was established. To improve the Dispute Settlement Mechanism, a new CSCE Court for Arbitration and Conciliation was to be established later in the year. And to improve the prospects for peacekeeping and enable it to dispatch its own peacekeeping missions, the CSCE declared itself a regional security organization under Chapter VIII of the U.N. Charter, and established procedures for better fact-finding and reporting from conflict areas.

The Conventional Armed Forces in Europe (CFE) treaties and CSBMs negotiated under the auspices of CSCE are all leftovers from the Cold War, when achieving a rough parity between two opposing military alliances was thought to be stabilizing. But in the current multipolar Europe, the concept of an East-West military balance has become meaningless.

As an illustration, Yugoslavia is not a party to the CFE treaties, so there are no limits on Serbia, the most heavily armed of the warring parties. At the CSCE Forum for Security Cooperation discussions in Vienna last fall, France sought to harmonize manpower and equipment ceilings with a proposal for a pan-European Security Treaty (acronym PEST), that would commit all the CSCE states to the same kind of equipment and manpower limits as in the CFE treaties.

Beefing up the U.N.

In attempting to deal with the wars in Yugoslavia, the international community reverted to the United Nations as the most appropriate institution to resolve the crisis. But none of the resolutions passed had effective military backing, so Slobodan Milosovic and his Bosnian counterparts were able to rampage at will, sometimes aided and abetted by well-intentioned efforts at humanitarian aid. The United Nations could be made a more effective collective security system—but it would require reviving the Military Staff Committee and becoming serious about each member nation's commitment to provide competent military forces at short notice.

Taking the United Nations more seriously is one solution to the nonproliferation problem. But more resources would have to be invested in the organization and its staff—its agencies would require greater numbers of competent experts. A security system needs to be able to field effective military intervention forces to reassure states that cross-border attacks will not be tolerated and that minority rights will be protected. This means that the major powers will have to provide effective peacemaking and peacekeeping forces to intervene in both inter- and intra-state conflicts, a more difficult task than keeping the peace in the old bipolar Cold War days when intervening in civil wars was unacceptable.

The potential exists to revitalize any number of international structures, but progress will ultimately depend on approval by the major European governments who must pay for the humanitarian or military actions. The U.N. Security Council will have to sanction any action, but for operational coordination, NATO looks like the best bet for a number of reasons. It already has a working military structure and, of all the existing organizations, can best coordinate military operations. But NATO would have to make some specific guarantees to its European neighbors and change its mandate so that it could operate outside its narrow area. Germany's allies would have to pull their weight to help solve the refugee problem in Europe; Germany, in turn, would have to provide peacekeeping and—where necessary—peacemaking forces.

In all this restructuring, special care will have to be taken to protect the rights of minority communities in Europe, not only in the interests of nuclear non-proliferation but also in the interests of long-term political stability. In 50 years, today's minorities could well be majorities and the descendants of today's elites will be pleading for their rights. Far better for the majority to establish strong legal norms for minorities now.

International institutions are only as strong as their constituent governments. The current crises show that Europe clearly lacks that leadership. This is also true of the United States. Where the United States does not lead, Europe does not follow. Much is expected of the new U.S. administration, not only in the United States but throughout the international community, and not only on the issue of nuclear nonproliferation, but on the whole collection of international security issues. ■

Jane Sharp directs the Defense and Security Program of the Institute for Public Policy Research (IPPR) and is a senior research fellow in the Department of War Studies, King's College, London.

ASIAN AMBITIONS, RISING TENSIONS

By RYUKICHI IMAI

The superpower arms race may be over, but nuclear ambitions and political instability pose serious threats to Asian security.

The role of nuclear weapons was clear, or so it appeared, during 45 years of East-West confrontation. There were a variety of strategic doctrines, as well as approaches to the use of a mixture of strategic and tactical weapons, particularly with regard to the central role of Europe. It now seems that the logic of these weapons had more to do with prevalent versions of warfighting than with their reliability or reality. Rationales for these vast arsenals have had an air of surrealism, and the accumulation of weapons became less and less connected to the actual use of an individual warhead.

With the end of the Cold War, it is increasingly difficult to justify the existence of nuclear weapons. Their reduction, dismantling, and eventual disposal—especially in the former Soviet Union, which may have lost effective control over its strategic and tactical weapons—present problems of unprecedented gravity. These issues will intensify the already complicated problems of nuclear proliferation in the Third World.

There have been many expressions of concern about the former Soviet Union's nuclear weapons. But little attention has been paid to how Soviet weapons relate to Asian security.

The Soviet Union deployed a number of intercontinental ballistic missiles along the Mongolian border, patrolled the Sea of Japan with Backfire bombers equipped with air-launched cruise missiles, and stationed submarines with ballistic missiles at Petropavlovsk, on the Kamchatka peninsula. Air-launched tactical weapons were based from Vladivostok to Sakhalin. The fate of these weapons is now uncertain, and no plans for their removal or dismantling have been made public.

Other strategic and tactical weapons are known to have been deployed in Kazakhstan and the eastern autonomous republics within Russia. They also require special attention.

If Russia wishes to receive financial and technical assistance from the outside world, a credible account of these weapons' whereabouts, and details of their proposed disposal should be reported to the international community. This requirement includes the orderly transportation, storage, and dismantling of some 20,000 nuclear warheads under careful supervision. Chaos in the former Soviet Union and the possible impact of economic shock therapy mean that the existing system cannot be completely trusted with this task. The world community needs to defend itself against proliferation—of warheads and of weapons engineers. Considerable financial aid is being provided for dismantling, and a sufficient level of information should be required if Russia is to receive continuing or increased aid. The problem of sufficient information about U.S. warhead dismantling may someday be similar, although of a lesser magnitude. An increased flow of information is critical in dealing with the excessive numbers of nuclear warheads produced during the Cold War period.

That the superpowers agreed to leave *only* some 3,000–3,500 strategic warheads in Russia (according to the Bush-Yeltsin accord of June 1992) is no "favor" to the rest of the world. There is no justification for these numbers other than convenience; they go far beyond the numbers needed for sufficient deterrence. Boris Yeltsin (and possibly George Bush as well) must have grossly misunderstood the situation if they believed that 3,500 warheads represented their "right." The world community will not be amused to see a nation—Russia—acting as if it were a nuclear superpower while asking for financial aid from abroad. All the assistance that may be provided—and it should come primarily from Europe—is to keep the disintegrating former Soviet Union from hurting the rest of the world.

Japan is keenly concerned about instability in Central Asia and far eastern Russia, and about potential upheavals in China, which may go through a period of major uncertainty. Japan is already providing a major aid package to China, and it would be prepared to extend aid to Russia as well, but only if conditions are right. Japan's position goes far beyond the dispute over Japan's northern territories, which is often misunderstood; it concerns the level of Russian awareness of their military, economic, and social condition, as well as their potential to damage East Asian security as a whole.

It is difficult to predict what will happen in China when Deng Xiaoping passes from the scene. There are some who foresee a loose federation of republics, with separate regional powers in the Northeast, in Beijing, in Guangdong, in Tibet, in Inner Mongolia, and in Central Asia. What will happen to China's nuclear forces is uncertain even without such an extreme scenario. But Chinese history is full of examples of local warlords in far outlying areas seizing military control and establishing autonomous states. The same could happen again, leaving Beijing in the same position Moscow finds itself today.

China has purchased many Russian weapons, including Sukhoi-24s, Sukhoi-27s, MiG-31s, T-72s, and even a Varyag aircraft carrier, which is under construction in Ukraine. At the same time, China's position may not be immovable. China today may well regret the help it reportedly gave to the North Korean nuclear program. And it is possible that China's economic needs will force it to stop its current expansion of its nuclear and conventional arsenals.

Not much attention has been given to India's weapons capabilities. India, which has remained silent since its 1974 underground test, has too much to lose by announcing itself a nuclear power, even tacitly, as Israel did. Pakistan has a similar, if not more severe, problem.

The uncovering of Iraq's nuclear program has led to a number of interesting observations. The Iraqi pro-

A fine point of nuclear theology

It was never clear whether, as postulated in strategic doctrines, either or both of the superpowers could have started an all-out missile attack on the other. Liquid-fueled SS-18s are extremely difficult to keep on alert, and test launches of Minuteman missiles have not always been a complete success. Maintaining the missiles and their associated hardware has posed a formidable problem. The same applies to maintenance of warheads, seeing to their safety and reliability, and accounting for the life of their batteries and neutron sources. The instability of the weapons' high explosives posed another problem.

Had the missiles been launched, disturbances in the field of gravity near the North Pole would have confused actual targeting accuracy. Moscow or Washington would have had many things to do before their respective communication links were secure and they could finally transmit firing orders.

If all-out heavy missile attacks were not realistic or feasible, then the "window of vulnerability" was nothing more than a fine point in nuclear theology on which billions of dollars and the finest scientific and engineering talents have been wasted. And it is not in the former Soviet Union alone that the concentration of national resources on nuclear and associated weapons resulted in the gradual erosion of industrial capabilities.

—*R. I.*

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gram proved that there are always businessmen willing to sell sensitive technologies whenever a customer has cash at hand. A list of names of the companies who provided components and other useful information was seized by an international inspection team. The list was not released, but the names on it were given to their respective governments. This led to an update of the London Guidelines in February 1992. But the program has also proven that there is a large gap between theoretical knowledge and production know-how. In spite of speculations about how close Saddam Hussein was to his target, he was more than a year away from obtaining a meaningful amount of highly enriched uranium, and there would have been still more years before enough uranium metallurgy could be learned to put 20-plus kilograms into a weapons-shaped core, together with all the other equipment required to create a usable implosion device.

It is difficult to determine if North Korea is or is not at a similar stage of nuclear development. Without first-hand knowledge of its industrial infrastructure, it is not possible to judge the level of its technical and industrial capabilities. The International Atomic Energy Agency (IAEA) has videotaped North Korea's nuclear research activities, and these tapes seem to indicate that North Korea has not-very-modern but competent technology. North Korea seems to be having technical difficulties with the chemical treatment of spent-fuel-pond water, which is needed to slow the corrosion of the cladding of spent fuel typical of a Magnox-type reactor. It is not possible to judge from these videotapes how North Korea is handling this spent fuel. Until more is known, either through IAEA inspections or through a North-South mutual inspection regime (should the North, in the end, decide to reverse its decision to withdraw from the Nuclear Non-Proliferation Treaty)—it is very difficult to make a meaningful judgment about the possible impact of North Korean nuclear weapons in the future.

"Dad, there's a salesman here who wants to talk to you!"

For a long time Japan's basic defense posture held that the Soviet Union was the potential enemy against whom the U.S. nuclear umbrella would work. Today U.S. tactical nuclear weapons have been withdrawn from all of South Asia except Guam, but the U.S. nuclear umbrella continues, making the U.S. presence felt in the still uncertain Asian power balance. It would require a major change in U.S. foreign policy for it to abandon this traditional role.

But many upheavals have accompanied the basic transformation of the U.S.-Russian relationship. Changes have already rocked the former Yugoslavia, altered the inter-European political balance, and led to a Labor Party-led coalition in Israel. A looming danger is the possibility that an Islamic region—extending from the Fertile Crescent through the Central Asian plateau all the way to Indonesia—could be both fundamentalist and nuclear. Peace talks in Indochina are in doubt; they may be beyond the capabilities of the United Nations to bring off, unless the relationship with and among Cambodian neighbors can be clarified.

What for Japan once looked like plausible defense plans are no longer realistic. Even a reconstructed Russia would not pose the same level of military threat as did the Soviet Union.

On the other hand, China's plans seem ill defined and they will remain so until someone appears on the scene who can negotiate on behalf of China in its entirety.

The role of the U.S.-Japanese mutual security treaty is not as clear as it used to be. U.S. forces based in Japan send an important political message and provide a significant trip-wire effect. Given Japan's many heavily armed neighbors, Japan wants U.S. forces to remain. But if paying the cost of stationing U.S. forces in Japan is no longer enough to keep them, Japan would have to engage in an expensive rearmament program of its own.

It is not easy to know what kind of a threat a unified Korea might pose to Japan's security. With an alleged nuclear weapons program in the North, it is not entirely inconceivable that a new, unified Korea—or North Korea separately—might command nuclear-armed ballistic missiles with a 1,000-kilometer range, sufficient to threaten Japan.

With China's future policies unknown, it might be prudent for Japan to focus on building missile defenses

against a small number of nuclear missiles homing in from the general direction of the Korean peninsula. It is inconceivable that Japan would develop either a nuclear deterrent or expand its conventional offensive capabilities.

It is not likely that the Patriot missiles used in the Gulf War could reliably protect Japan from missiles whose reentry speed is more than nine times the speed of sound. Japan may want to invest in some version of strategic defense, perhaps by working jointly with the United States to build a ground-based kinetic-kill defense system. The new direction of U.S.-Japanese security cooperation may lie in the development of technical and other means of defense against a small number of medium-range nuclear missiles.

Another component of a new defense/deterrence capability would be a set of early warning and tracking satellites, with information transmitted through relays to strategic defenses either on the ground or in space. But it is not clear if the United States will continue to invest in its strategic defense program at the same level of funding. It is even more questionable whether the United States would be willing to share its enormous satellite reconnaissance capabilities.

The United States has treated satellite reconnaissance as highly classified. For instance, it would not have been difficult to share information about observations of the North Korean reactor at Yongbyon, its operational status, and calculations of its fuel burn-up. If the United States knew details about the quality of North Korean plutonium, it has not shared much of that knowledge. Getting military information on a real-time basis might be even more complicated.

Japan hopes to launch its own satellite, and has been developing the "H-2" engine, which has been delayed by a series of failures. Once Japan is in a position to launch, it may be feasible to organize an international entity for the joint launch and management of satellites and for the acquisition and processing of data. It could serve as a multilateral platform for verifying nuclear and other disarmament arrangements, provide early warning of attack preparations or of an actual launch of hostile missiles, and if feasible, do the additional job of keeping watch on the environment. So far, the verification of nuclear arms control and disarmament has been left solely in the hands of the two superpowers, while the rest of the world only listened to bilateral debates over possible violations.

In a no-longer-bipolar world, parties other than the two former superpowers should be involved in satellite-based verification and international observation. An internationally organized satellite reconnaissance program could help solve the problem of how to trigger IAEA special inspections.

That this international satellite body should start with a rather restricted membership—of those financially and technically capable and willing—is a delicate and sensitive point. But those who have experience working in multilateral fora will understand. The U.N. General Assembly, with 175 members, is not an ideal model for a technically oriented international organization. It is better to start out as an informal group of a few like-minded countries.

The satellite organization will need to make swift and decisive moves in order to develop, deploy, and manage a sufficient number of satellites to adequately monitor critical parts of the globe. The organization will have to learn to handle sensitive information about a number of sovereign states.

One idea is to create an umbrella organization with an enlarged membership, or perhaps to function under the umbrella of the entire U.N. membership. The larger international body could delegate activities to specialized groups, which would have the same independence as that of the safeguards section of the IAEA. The newly formed organization that will oversee verification mandated by the Chemical Weapons Convention and an international satellite organization would both be suitable specialized-group candidates. Such a separation of functions would enable each verification or observation group to concentrate on technical aspects and exercise related political judgment; the umbrella structure would insure participation by all, and assure all an opportunity to participate when the interests of the world community as a whole are concerned. ■

Ryukichi Imai, a counselor to the Atomic Energy Commission of Japan, is a distinguished scholar at the International Institute for Global Peace. He is currently a visiting professor at Sophia University in Tokyo.

AN EQUAL-OPPORTUNITY NPT

By K. SUBRAMANYAM

There is a way to fit the three de facto nuclear weapons states—Israel, India, and Pakistan—into the Nuclear Non-Proliferation Treaty.

The world has gone through a momentous revolution. The Cold War ended with the Paris Conference of 1990, and in a historically unprecedented event, two powers, both capable of destroying the world several times over, decided to cut back their arsenals and end 45 years of confrontation.

But a world conditioned by four decades of a nuclear weapons cult cannot shed its nuclear arsenals overnight—even if significant reductions by the two leading nuclear powers is a good beginning. Their agreement should be followed by bringing the other three nuclear weapon powers, especially China, into the arms reduction process. Even then, superpower arsenals will far exceed levels needed for the purpose of deterrence. Further arms reductions must be pursued.

The Nuclear Non-Proliferation Treaty (NPT) has finally achieved its original purpose—to slow down and reduce nuclear proliferation to a minimum. In 1962, when Leonard Beaton and John Maddox wrote a book on the spread of nuclear weapons, they could already foresee that Israel and India would become nuclear-weapon states. Since then, we have seen Pakistan join the group, whereas South Africa built—and then claims to have abandoned—a nuclear capability. By and large, the NPT has been a success.

But now the international community must decide how to fit the three de facto nuclear states—Israel, India, and Pakistan, whose perceived need for a nuclear deterrent could be considered greater than that of the Western powers—into the treaty's framework when the NPT comes up for extension in 1995.

The Western nations want to extend the treaty indefinitely, and they will probably have the support of the majority of NPT members. Those who oppose the indefinite extension of the treaty—on the grounds that the declared nuclear-weapon powers should commit themselves to a comprehensive test ban beforehand—are likely to be placated by a U.S. promise to accept a test ban by 1997. It does not seem likely that the treaty can be amended—too many fears have been expressed about the danger of revising the treaty. Some feel that any attempt to alter the treaty could cause it to unravel altogether. But perhaps a way can be found to develop a universal non-discriminatory nuclear restraint regime without touching the present treaty.

A supplementary treaty could be adopted that would bring all nuclear installations (in both nuclear-weapon and non-weapon states) under a universal non-discriminatory verification regime similar to that of the chemical weapons treaty. In fact, it would be easier to work out a verification scheme for nuclear weapons than it was for chemical weapons.

The treaty could prohibit all future manufacture of nuclear weapons, impose a comprehensive test ban, and institute an intrusive, non-discriminatory verification regime on all countries.

Since the Western nations and Russia are either reducing their arsenals, or satisfied with their present weapon levels, they should have no difficulty in accepting a ban on the further production of weapons. Countries like India would not object to coming into such a treaty, either. (This is my personal view—this proposal, I believe, is a new one, and I cannot vouch for the Indian government's position.)

The supplementary treaty would cap all future nuclear weapon-related activity all over the world. Negotiations for this treaty could start now, in Geneva, in the Committee on Disarmament, and it could be ready for adoption along with the NPT extension in 1995.

The new treaty should include a "no-first-use" declaration by all known nuclear nations as well as by those believed to have undeclared weapons. The United Nations would be assigned mandatory retaliatory measures in case of a breach. That would meet the demands of non-nuclear-weapon states for security assurances, and it would be a first step toward the delegitimization and elimination of nuclear weapons. But it would not jeopardize the deterrent arsenals of those nations that feel that they must maintain them.

This proposal could not have been made before the end of the Cold War, or before the U.S. Congress sponsored a comprehensive test ban. Now nations are accepting a strategy of lesser reliance on nuclear deterrence—although they are not abandoning it. Meanwhile, they appear willing to accept the intrusiveness of the chemical weapons treaty's verification procedures. This proposal, which revives the idea of a "freeze," would not limit that freeze to the two leading powers, but would cover all nations. It would eliminate the discriminatory character of the NPT and introduce a strict verification system, correcting the two major shortcomings of the earlier treaty.

Some may ask whether a new treaty is necessary—and whether a comprehensive test ban, a no-first-use policy, and a cap on the production of fissile materials and weapons verification could not be achieved by individual agreements supplementing the NPT. No doubt that could be done. However, the NPT highlights the distinction between weapon and non-weapon states in respect to verification. Extending the NPT would only signify a consolidation of the status quo; but a new treaty incorporating the above objectives would demonstrate that the world has made tremendous progress since 1968, when the NPT was originally signed.

"Hey ! You guys aren't supposed to be digging around in there!"

Even as a global regime of nuclear restraint may be developed, there is also an opportunity for regional restraint in South Asia. A realistic approach to the nuclear issue on the Indian subcontinent should start by accepting reality and abjuring the political posturing of both India and Pakistan. This means recognizing that both Pakistan and India have nuclear capabilities that cannot be reversed; there is no way to make a nuclear-weapon-capable state non-nuclear. Therefore, solutions based on making India and Pakistan non-nuclear countries—or treating them as if they were—are not viable. Suggestions of a nuclear-weapons-free zone or attempts to induce the two nations to join the NPT at this stage are not relevant. Ending the production of fissile material and mutual inspections may be possible, but these steps are not likely to be politically acceptable to India unless China is brought into a verification regime, joins the disarmament process, and agrees to discontinue testing.

Realistically, neither India nor Pakistan will advance beyond a minimum deterrent capability for quite some time. In the meantime, confidence-building measures, progressive arms control arrangements, and a cap on nuclear capabilities that takes into account the respective security concerns of the two countries, could be negotiated.

In both countries there have been independent suggestions that the agreement not to attack each other's nuclear facilities should be followed by a no-first-use agreement. The next steps could be risk reduction centers, an "open skies" plan, and discussions between military staffs on strategic doctrines and interactions between strategic thinkers. Confidence-building measures on conventional and nuclear arms should proceed side by side.

India has taken the lead in matters relating to disarmament. But neither Indian nor Pakistani diplomats have acquired expertise in arms control. India has been reluctant to engage in arms control discussions, and the problem is further exacerbated by inadequacies in the interactions between India and Pakistan, and the tendency of both sides to indulge in rhetoric mostly meant for domestic consumption. Pakistani proposals are the standard ones recommended by Western arms controllers for developing nations, and they are made knowing full well that they are unacceptable to India. Indian officials reject these proposals outright, and fall back on the first principles of disarmament, which they know cannot be implemented straight away. Recently, however, the situation has improved somewhat, and some unofficial exchanges have begun.

No Indian government could sign the NPT and survive. This is one issue on which there is consensus. That France and China joined the NPT is irrelevant; India could join the treaty, but not in a "lesser" category. Indians feel that the West does not adequately appreciate the depth of public opinion in India about nuclear apartheid, which has nothing to do with India wanting to build a nuclear arsenal. The Western debate over nuclear issues in South Asia has never taken into account the psychology underlying Indian resistance to the NPT. (Nor has the Western literature ever explained why India did not follow the example of the other nuclear-weapon powers and build an arsenal following the Indian nuclear test in 1974.)

Similarly, the Indian government has not made adequate efforts to communicate its rationale to the world at large, due to the absence of arms control expertise. Since Pakistan admitted its nuclear status, there is more pressure on India to think about this issue, but it is still not high on the Indian government's agenda.

There have been a few cracks in "nuclear theology" in the past seven years, but post–Cold War strategic thinking has yet to take tangible shape. Meanwhile, many nuclear theologians are looking for new adversaries to replace the collapsed Soviet Union—reflecting a continuation of the Cold War mindset. The views of the politico-military establishments of most of the industrial nations on the enforcement of the NPT do not take into account the revolutionary changes that have taken place in the global strategic environment. The treaty was the product of a time when the major powers of the world were embarking on an arms race within an agreed framework. Twenty years later, the world had four times as many weapons as it had at the beginning.

Now arsenals are being reduced. It seems likely that even nuclear deterrence may decay over a period of time. The Israeli nuclear arsenal has existed for well over two decades. The Indian nuclear test was conducted 18 years ago. These nations have demonstrated maturity and a sense of responsibility for longer periods than the sponsoring nuclear weapon powers had when they signed the NPT.

India and Pakistan are engaged in what George Perkovich of the W. Alton Jones Foundation has called "non-weaponized nuclear deterrence." An Indian analyst, Jasjit Singh, has dubbed this "recessed deterrence." This could be a stable situation if the necessary steps for confidence building are initiated between the two nations and they do not convert or deploy their weapon capabilities in a provocative manner. Recessed deterrence provides the advantages of mutual nuclear deterrence at the lowest level of risk.

The logic of a supplemental treaty may not be apparent to those conditioned by conventional wisdom on proliferation. But today the most dangerous risk of proliferation arises from the breakdown of the Soviet nuclear arsenal and likely seepage of fissile materials, weapons, and nuclear technology talent to nations and non-state actors interested in acquiring nuclear weapons. The manner in which the West responded to a possible single weapon in the hands of Iraq shows the exaggerated importance attached to the possession of a weapon or two. Yet the five declared nuclear powers continue to maintain their nuclear arsenals, and the fact that they also happen to be the five permanent members of the Security Council reinforces the association of power and prestige with the possession of nuclear weapons.

Preaching to other nations that nuclear weapons have no military utility while continuing to maintain thousands of warheads not only fails to evoke credibility, it raises legitimate suspicions and fears about motivations.

The most difficult task ahead is to prevent the transfer of fissile materials and weapons in a world where ethnic and nationalistic struggles are causing fragmentation. It will be difficult to track the movement of materials so long as nuclear weapons are considered legitimate. For example, Japan is already asking why its reactor-grade plutonium should be subject to elaborate safeguards when the United States and Russia are contemplating large-scale transactions in weapon-grade material that will escape inspection.

In all probability, over the next few decades, nuclear deterrence will decay, and the nuclear powers will phase out their arsenals for economic reasons. The longer it takes to achieve this goal, the greater are the intermediate risks arising from "loose nukes." Initiating a new treaty could bring about a universal, non-discriminatory safeguard regime, and it would give the world an opportunity to recover from more than 40 years of nuclear conditioning and adjust to current realities. ■

K. Subramanyam, chairman of the U.N. Study Group on Nuclear Deterrence, is a contributing editor of Economic Times *in New Delhi.*

A SACRED MATTER

By AVNER COHEN

Israel's nuclear project was not for national glory or prestige. It was perceived as a sacred matter of national survival.

In the Middle East, the future of nuclear nonproliferation depends on progress towards the political settlement of the Arab-Israeli conflict, as much as on proliferation developments in those regional states that are currently outside the peace process. The present situation is a mix of good and bad news.

The good news is that both moderate Arab states and Israel share a genuine concern about nuclear proliferation and the need to deal with it on a regional basis. Furthermore, in conjunction with the bilateral peace talks, there is now a regional forum—the Multilateral Working Group on Regional Security and Arms Con-

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trol—to discuss these issues. The bad news is that the region's most determined proliferators, Iran and Iraq, are not parties to this forum. While Iraq still faces restrictions imposed by the U.N. Special Commission, Iran is on its way to building a broad nuclear infrastructure.

It is precisely because of this last issue that the interests of Israel and the moderate Arab states seem to converge. Behind the Arab rhetoric, there are indications that moderate Arab states are more concerned about Iranian and Iraqi nuclear ambitions than about Israel's quarter-of-a-century old "nuclear option." Indeed, while Israeli nuclear deterrence is seen by some Arabs as playing a positive role in promoting the cause of Arab-Israeli peace—giving Israel the courage to make painful territorial concessions—Iranian and Iraqi proliferation is the region's nightmare.

Even though Middle Eastern arms control is unlikely to make progress in constraining Israel's existing nuclear capabilities without making similar progress in stopping proliferation in Iran and Iraq, it is still worth asking what a realistic nuclear arms control agreement in the Middle East could look like (in theory at least), and how it should be negotiated.

Israel, the only nation in the region with nuclear capability, will not agree to talk about "eliminating" or "dismantling" its nuclear weapons, because it has never "introduced" them in the first place. The Israeli bomb remains what it always has been: opaque, invisible and unacknowledged. Israel's official position has always been ambiguous, neither confirming nor denying its nuclear status, only pledging "not to be the first to introduce nuclear weapons to the Middle East." Israel has never defined what "to introduce" nuclear weapons really means, or what its definition of "nuclear weapons" is.

Given Israel's holocaust trauma and the threats it faced from its neighbors, its decision in the late 1950s to acquire the "nuclear option" could be defended on both political and moral grounds. Israel's nuclear project was not for the sake of national glory or prestige. Rather, it was always perceived as a sacred matter of national survival, the only way to grant Israel the deterrence it needed—Israel must be in a position to inflict a holocaust to prevent another holocaust. As long as the nation finds itself confronted with threats to its existence, no Israeli government can bargain the nation's nuclear capability away. Polls taken during the Gulf War indicated that this view concerning the indispensability of nuclear weapons was overwhelmingly supported by the Israeli public.

"Feel free to browse, Hon."

Nuclear weapons remain for all Israeli prime ministers (who have jurisdiction over all Israel's nuclear activities) what they always were, essentially a psychological "insurance policy" for unthinkable contingencies, under the heading of "last resort." The assumption that has guided all Israeli governments and served as the basis of its long-term force structure planning was that as long as there were no Arab nuclear weapons, the Israeli army must plan all contingencies on conventional assumptions, as if no Israeli nuclear weapons existed. Indeed, the 1967 and 1973 wars (during which the Israeli "nuclear option" existed) only strengthened this lesson: nuclear weapons have no military utility in almost any situation in which Israel may find itself.

However, nuclear opacity may also highlight a sense of threat and intransigence in the minds of some. In the wake of the 1986 Mordechai Vanunu revelations concerning Israel's nuclear bomb program and Seymour Hersh's claims (in his book, *The Sampson Option*) about the Israeli nuclear arsenal, some Arab analysts interpreted Israel's nuclear posture as the means to compel Arabs to accept a "Greater Israel," while reducing Israel's risk of war. Yezid Sayigh, a Palestinian strategist, argued in the July-August 1992 issue of *Middle East Report*, that Israeli "[nuclear] capability has underpinned past refusal to contemplate political and territorial concessions."

Such claims are misguided. Whatever the composition of the Israeli nuclear arsenal is, it probably reflects a built-in commitment to technologi-

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cal development along with the institutional inertia inherent in such programs, rather than some ideologically loaded concept of Israeli national security adopted by the previous Likud government. And certainly this is not the strategy that guides the present government, which is committed to a peace process based on the concept of "land for peace."

Nevertheless, such issues are worth discussing informally in the context of regional arms control talks. If Israel seeks to legitimize its right to some nuclear shield as its ultimate insurance policy until true peace comes, it must be ready to explain more openly and honestly its views on these matters.

Such discussion rarely takes place in Israel itself, in public or even in private. I believe no Israeli cabinet or other political body has ever formalized a specific nuclear doctrine. The taboo against discussing these issues is too strong. But arms control discussions require some "socialization" of these matters. Such discussions could even be conducted in a semi-hypothetical mode, without forcing Israel to officially acknowledge anything.

Both Israel and the moderate Arab states support the idea of a nuclear-weapons-free zone (NFZ) in the Middle East, free of all weapons of mass destruction, as the ultimate end of regional arms control. But while the Arab states are eager to take up this issue sooner rather than later, Israel makes the point that an NFZ could be established only after a lasting Arab-Israeli peace was achieved. Discussing final nuclear arrangements now, before any political resolution, would be premature and unrealistic. In any case, the question of an NFZ cannot be discussed apart from the rest of the region's arms control agenda, especially the issue of substantive reduction of conventional forces.

Realistically, Israel would not be in a rush to dismantle its ultimate "insurance policy," even after a formal peace was signed. One should not abandon the ultimate goal of establishing a true nuclear-weapons-free zone in the Middle East as a regulatory vision, but one should also recognize that, realistically, no such arrangement can be established, and certainly not implemented, any time soon. To insist on a Tlatelolco-like NFZ treaty as the only solution—the "either/or" approach—means postponing the nuclear issue indefinitely. But instead of talking about final arrangements, the region could and should explore interim nuclear confidence-building arrangements based on present opacity.

In a September 1990 article in *The Journal of Strategic Studies*, Marvin Miller and I proposed the following interim arrangements. We advocated that the declared non-proliferation commitment of all the states in the region be reaffirmed and strengthened. A good start would be a public "no-first-use" pledge for the region's states regarding all weapons of mass destruction. The timing of such declarations would be determined by progress in the political process. Such a declaration is consistent with Israel's present stance. Nevertheless, it would be an important step toward acknowledging a regional taboo against the use of such weapons.

Such words should be reinforced by deeds. All non-nuclear Nuclear Non-Proliferation Treaty (NPT) states would accept the International Atomic Energy Agency's authority to make special inspections as required at both declared and suspected nuclear facilities. Israel, the only non-NPT state in the region, would not produce weapon-grade materials. In practice, this could involve a verifiable (but possibly undeclared) shutdown of some elements of the Dimona nuclear complex.

A similar idea is incorporated in the May 29, 1991, U.S. proposal for arms control in the Middle East that calls on the region's states "to implement a verifiable ban on production and acquisition of weapons-usable nuclear material."

One way to think about such a ban is as a unilateral Israeli action. Its major advantage is that such a decision eliminates the need for formal negotiations on the part of Israel, which might ultimately arouse suspicions instead of building confidence. To be sure, a formal regional agreement along such lines would be very difficult. Furthermore, by making a unilateral gesture of good will, Israel would take the lead in promoting the cause of non-proliferation regionally and globally. Israel could take its place among the nations that actively seek to promote the idea of a ban on the production of weapons-grade material as a new non-proliferation norm. If regional circumstances change, however, Israel would be free to reverse its decision.

If any nuclear arrangement is possible at all, it is difficult to think of a conceptual structure different from this one. This proposal is realistic because it takes into consideration, even appreciates, the opacity of the current situation. First, it is a future-oriented bargain, deliberately ignoring what has happened in the past. Second, it makes no generic or specific reference to nuclear weapons as such; instead it refers to "weapons-usable nuclear material."

In the past, nuclear opacity in the Middle East functioned as a substitute for discussion and negotiation, but it need not be that way in the future. Indeed, just as opacity helped to create constructive ambiguity in the past, it could also contribute to creating constructive ambiguities for future arms control. Just as the Middle East went nuclear opaquely, it could reverse that trend—opaquely.

Such a proposal would have a chance to be considered in Israel only if there is a significant movement on the peace front and a stronger and action-oriented international movement to outlaw proliferation. It is in the interest of the Rabin government to promote both. Nevertheless, it is naïve to believe that the threat to Israel will disappear overnight by signing a peace treaty. Indeed, almost all Israelis believe that retaining a "last resort" deterrent is an important instrument for preserving formal peace.

Israel was not the first state to acquire nuclear weapons, and given its particular security situation, it should not be expected to lead the world into the nuclear-free age. Minimizing the dangers of proliferation in the Middle East requires that the deep political conflict underlying the nuclear reality be addressed. The recognition that Israel's nuclear monopoly will not last forever is one of the strongest incentives for searching for peace. ■

Avner Cohen is co-director of the Nuclear Arms Control in the Middle East Project and a fellow at the Center for International Studies at the Massachusetts Institute of Technology.

MYTH-BUILDING: THE "ISLAMIC" BOMB

By PERVEZ HOODBHOY

The "Islamic" bomb evokes fearsome images—nuclear annihilation in the hands of dictators, holy war and warriors, and terrorists.

The "Islamic Bomb" is the title of a 1979 BBC television documentary, of a book by Herbert Krosney and Steven Weismann, of another by D. K. Palit and P. K. S. Namboodiri, and it is used often in a hostile context in various discussions and writings. Although imprecisely defined, the "Islamic bomb" is roughly understood to be a nuclear weapon acquired for broad ideological reasons—a weapon that supposedly belongs collectively to the Muslim *ummah* or community and, as such, is the ultimate expression of Islamic solidarity.

Concern about the Islamic bomb is at the heart of the intense effort to prevent the spread of nuclear weapons to Muslim countries. The official justification is a general one: proliferation must be curbed globally. But unofficially, the Islamic bomb gets special attention.

Terrorism is given as one reason. Another is the threat of Khomeini-style Islamic fundamentalism sweeping unchecked across the world, locked in *jihad* with infidels, willing and able to use the ultimate weapons of mass destruction in hope of reward in the Hereafter. A third reason, related to the second, is "Islamism" — the fear that Muslim solidarity will lead to, in times of crisis, the transfer of nuclear arms from nuclear to non-nuclear Muslim countries. A final reason involves location: the region is the jugular vein of the West; no countries in such a strategic location should be permitted to threaten oil interests.

So potent is the fear of an Islamic bomb that, in the post-Soviet era, it is the critical factor determining the nature of relations between the Western powers and those Muslim countries engaged in the pursuit of nuclear weapons. This fear is visible in the way that nuclear non-proliferation is enshrined as a key U.S. foreign policy doctrine for the 1990s. The Clinton administration is likely to become more involved in this issue than has any other previous U.S. administration. U.S. doctrine requires that all Muslim and non-Muslim non-nuclear states (with the exception of Israel), be persuaded, cajoled, or pressured until they renounce their nuclear ambitions.

U.S. seriousness about pursuing this doctrine is demonstrated by its objections to the sale of a Chinese reactor to Iran; by its refusal to reduce tensions with North Korea until that country suspends its nuclear program, by its suspension of economic and military aid to Pakistan as punishment for continuing nuclearization; and by the destruction of Iraq's nuclear facilities during and after the Gulf War.

The Islamic bomb is seen as a law-and-order problem, requiring appropriate police action or punitive measures. Media images have created fearsome scenarios, including a Saddam Hussein caressing the nuclear button. There is a growing current of opinion, voiced unofficially, that in the post-Soviet world, war must be waged against the Islamic bomb and Islamic fundamentalism. As Red and Yellow perils fade into history, the "Muslim peril" (with the Islamic

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Pervez Hoodbhoy is a professor in the physics department at Quaid-e-Azam University in Islamabad, Pakistan.

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"It followed me home—may I keep it?"

bomb in the background) has stepped into view.

But this perception is not helpful—in fact, it is extremely dangerous. Most discussions of the subject are either alarmist or narrowly technical, focusing on supply-side measures such as export controls and embargoes, or even on direct military action.

I believe, however, that proliferation—as a global phenomenon—is fundamentally a political problem and must be tackled as such. This does not mean that one must wait for all disputes between peoples or nations to be resolved before doing anything. But it does mean that the world community must take immediate and urgent steps to decrease the tensions that inspire countries to seek nuclear weapons, or—in the case of those with weapons—to contemplate their use.

This perspective demands an evaluation of issues related to nuclearization in Muslim countries. In particular:

- How important are broad ideological concerns—Islamic unity and defense against a common foe—as motivations for Muslim countries to seek nuclear weapons? Would Islamic solidarity be expected to play a substantial role in transferring weapons or technology to another Muslim country?
- How do Muslim countries perceive U.S. efforts to limit the spread of nuclear weapons?
- What accounts for the fact that, among the nations of the South, the deepest level of antagonism to the West is found in Muslim countries?
- Why do so many developing countries seek nuclear arms? If Pakistan had been a Christian country, would it still have sought the bomb?
- What are the technical barriers to proliferation? What is the current level of nuclear development in Muslim countries interested in acquiring nuclear weapons? What of the future?
- What possible course of action by the world community can limit the further spread of nuclear weapons and decrease the chances of eventual nuclear conflict?

Defined

The Islamic bomb evokes fearsome images: the power of nuclear annihilation in the hands of dictators, holy war and warriors, and terrorists. But Muslims, whether moderate or extreme, resent the use of the phrase even if they support, at some level, the idea of a bomb for Muslims. Why talk of an Islamic bomb but never of a bomb labeled with another faith?

Irrespective of whether or not an Islamic bomb can or cannot, or should or should not, exist, the concept behind the term is of Muslim origin. The idea of a nuclear weapon for collective defense of the entire Muslim *ummah* was, after all, articulated and advocated by Muslim leaders who recognized its popularity and determined to benefit from it.

Addressing posterity from his death cell in a Rawalpindi jail, Zulfikar Ali Bhutto, the architect of Pakistan's nuclear program, wrote: "We know that Israel and South Africa have full nuclear capability. The Christian, Jewish, and Hindu civilizations have this capability. The communist powers also possess it. Only the Islamic civilization was without it, but that position was about to change."

Another Muslim leader stressed the need for a bomb belonging collectively to Islam. Addressing an Islamic conference in Teheran in 1992, the Iranian vice-president, Sayed Ayatollah Mohajerani said, "Since Israel continues to possess nuclear weapons, we, the Muslims, must cooperate to produce an atomic bomb, regardless of U.N. efforts to prevent proliferation."

Echoing similar pan-Islamic sentiments and arguing against weapon-limitation treaties, Agha Murtaza Pooya, a Pakistani politician and the owner of an influential Islamabad newspaper, recently wrote: "Indigenous improvisations by Muslim governments to missiles and mass destruction technologies gave their arsenals a force-multiplier effect, thus marginalizing the preponderant Indo-Zionist might. . . . All will be bartered away if we submit—singly or jointly—to the perverse prescription of de-Islamization, de-nuclearization, and demilitarization being peddled by the Ziono-Indian-U.S. triaxis. . . ."

The bomb as panacea

The bomb looms large in the popular Muslim consciousness as a symbol of Islamic unity, determination, and self-respect. It is seen by many as a guarantee against further humiliating defeats, as the sure sign of a reversal of fortunes, and as a panacea for the ills that have plagued Muslims since the end of the Golden Age of Islam. Such sentiments are echoed by Muslims from Algeria to Syria, and from Iraq to Pakistan. A country that could turn this symbolism into reality would have the support of hundreds of millions of Muslims the world over. It is therefore natural that Pakistan, a Muslim country that is now a de facto nuclear state, should indeed enjoy considerable financial and political benefits from oil-rich Arab countries. Similarly, Dr. Abdul Qadeer Khan, the guiding spirit behind the uranium enrichment program, is venerated in Pakistan as a national hero.

Such "evidence" seems to indicate that the Islamic bomb could become a reality, if not immediately, then in the not-too-distant future. But this would be a wholly incorrect deduction. There cannot be an Islamic bomb unless certain drastic developments occur.

An elusive goal

While religious and political leaders proclaim the existence of one Muslim *ummah* and speak rhetorically of its common defense, the fact is that this goal is more elusive now than ever. Unity has never been a Muslim strong point. Violent internecine struggle began almost at the beginning of Islam. After the death of the Prophet, the question of who should be the next caliph caused divisions among the faithful so deep that the passage of 14 centuries has not healed them. Today the Sunni-Shia split is as hostile as ever, and it has been augmented by numerous and frequently violent quarrels among Sunni sects. In 1974 the Ahmadi sect was excommunicated from Islam by an act of the Pakistani parliament, and extremists have launched a powerful movement aimed at excommunicating Zikris, Ismailis, and Shias.

At the political level, history bears witness to the negligible role that the collective Islamic consciousness has played in matters involving real issues of power. Much as Christians have fought each other for power over the centuries, Muslim dynasties have also battled. The Ummayads were destroyed by the Abbasids, the Abbasids were wiped out by the Buwayhids, and so on. In the famous battle of Panipat in India, the first Moghul king wrested power from another Muslim king. Later, Moghuls fought bitterly against Afghan and Persian invaders from the north who were also Muslim. Even when Muslims have been pitted against nonbelievers, Muslim solidarity has failed to coalesce: the Arab rulers of Spain allied themselves with Christian invaders against other Muslim rulers, and in India, even arch-conservative Muslim rulers like Aurangzeb allied with Hindu princes to fight local Muslim opposition.

Today, oil-rich Arab countries pay lip service to the Palestinian cause—which they regard as an Islamic cause—while investing their dollars in the United States, Israel's prime supporter and underwriter of its expansion into areas captured through war. The systematic destruction of Beirut in 1982, the Indian security forces' crimes against Kashmiri Muslims, and the Serbs' genocide inflicted upon Bosnian Muslims—all have failed to elicit a significant response from the Muslim community at large.

There are many examples of national fervor or a common language functioning as a far more powerful source of group identity than shared faith. For example, the Pakistan army was a violent instrument of oppression for Bengalis; Syrians organized the Tel-al-Zaatar massacre of Palestinians; and Iraq, Iran, and Turkey have jointly persecuted Kurds. The list is long.

In truth, pan-Islamism, the dream of nineteenth-century reformers like Jamaluddin Afghani, is a myth whose pursuit has yielded naught. As a modern corollary, the Islamic bomb is a meaningless notion. Individual Muslim countries may desire nuclear weapons, and some have been engaged in that enterprise for many years, but the motivations are essentially secular and nationalistic, although cloaked in Islamic garb. Just as Israel's nuclear weapons are intended to serve the state of Israel and not Judaism, so too the weapons sought by Pakistan, Iran, Iraq, and possibly other Muslim countries, are intended to serve the pur-

"Excellent! All we need now are uniforms!"

poses of their states.

From time to time, the media reports the speculation that Pakistan would provide a "nuclear umbrella" for Arab countries in a crisis. But nothing in the history of Pakistan has shown a substantial commitment to an Islamic cause. Pakistan is unlikely to risk devastating retaliation from Israel or the United States if it did attempt to provide nuclear weapons for use in the Middle East. Nuclear cooperation with Iran, in addition to carrying unacceptable dangers and the threat of economic sanctions, would be further inhibited by the longstanding Shia-Sunni hostility. (These arguments do not rule out clandestine transfers of nuclear know-how, at some level, for political or economic reasons. French nuclear assistance to Israel, and Chinese to Pakistan, are instances where neither shared religion nor ideology was the motivation.)

Disarming the disarmed

In 1981, President Ronald Reagan, told by his national security adviser that American-supplied Israeli warplanes had destroyed the nuclear power plant in Osirak, Iraq, is said to have pondered for a moment before remarking, "Well. Boys will be boys." For most Muslims, particularly in the Middle East, U.S. advocacy of nonproliferation measures is a cynical and transparent ploy. Non-proliferation appears to be empty pontificating coming from a power seeking to arm the armed while trying to disarm the unarmed.

Israel, which shares high-level defense technologies and intelligence data with the United States, is determined to be the sole nuclear state in the Middle East—by use of force, if necessary. Mordechai Vanunu's revelations suggest that Israel may possess about 200 warheads, some of them "boosted" weapons with H-bomb power. It also possesses an advanced delivery system with the Jericho and other missiles. To Muslims, U.S. complicity is evident both in Israel's nuclear arming and in helping Israel keep its adversaries de-nuclearized. When Israel was expelled from the IAEA for bombing the Osirak reactor, the United States temporarily withdrew from the organization.

The United States has welcomed numerous Israeli efforts to prevent the nuclearization of Arab states. About three years before the Osirak raid, Israeli secret service agents blew up the core of a French experimental reactor, which was to be shipped to Iraq from La Seyne-sur-Mer. Today, with the Iraqi nuclear program inoperative, Iran is now the focus of dark predictions and veiled threats by Israeli military intelligence.

If past history is any guide, fears of possible future Israeli military action—directly or indirectly supported by the United States—against Iran, or even against the Pakistani enrichment facility at Kahuta, are not baseless. But will the Israeli strategy of nuclear espionage and military force continue to work indefinitely? Apparently many Israelis think it will, or they see no alternative.

But some Israelis recognize that Israel's nuclear monopoly may eventually break; advances in technology will make it impossible to keep nuclear weapons away from its adversaries. Moshe Arens, for example, has stated that Israel's adversaries will possess nuclear weapons within the next ten years. For Israeli hawks, this means that Israel must develop a second-strike capability. A second-strike capability would mean still more warheads, hardened underground missile silos, and possibly nuclear-armed surface vessels or submarines.

The glimmerings of a more moderate tendency within Israel do exist. There is some recognition that Israel must come to terms with its Arab neighbors, as well as with the native population it has forcibly dispossessed, by trading captured lands in exchange for peace. Shimon Peres, a former prime minister and one of the architects of the Israeli nuclear program, now argues: "Science is more important than land. We cannot rely on a military solution, only economic and political ones. Israel cannot bomb centrifuges in caves. We have five years—ten years at the most—to make peace or we'll have a nuclear Middle East."

As yet, this appears to be a minority view in Israel, where the nuclear issue is usually swept under the rug. Nevertheless, it promises hope of a negotiated settlement. A wildly optimistic view would be that, eventually, a preponderance of such attitudes will lead to a nuclear-weapons-free zone in the Middle East. Peace in the Middle East—should it ever be achieved—would go a long way toward reducing Muslim antagonism to the West. But the roots of such antagonism are deep.

Roots of antagonism

In the days preceding the U.S.-led assault on Iraqi forces in Kuwait, a besieged Saddam Hussein stitched the Muslim battle cry *Allah-o-Akbar* onto the Iraqi flag and prayed before television cameras. It was an anxious appeal to the power of political Islam and its ability to mobilize opposition to the West. Twenty years earlier, this leader of secular Arab nationalism would have raised the banner of pan-Arabism, a movement that met disgrace after repeated defeats of Arab forces on the battlefield. But now Hussein's call was for *jihad*, and the language used by Baghdad radio throughout the war was laden with Islamic symbolism. For example, as in the Arab-Israeli war of 1973, Iraqis killed in war were described as *shaheeds* (martyrs) rather than as patriots. This strategy worked even though the war was lost; Hussein succeeded in evoking a powerful emotional response among millions of Muslims the world over.

This raises questions that seem to have no reasonable answers: Why did many Muslims, possibly a majority, choose to ignore Hussein's invasion of Kuwait and his bloody crimes against other Muslims in Iraq and in Iran, and, instead, align themselves emotionally against the U.S.-led alliance? Why do neo-fundamentalist Islamic movements have so much support when, in fact, most of their targets are other Muslims? Fundamentalist Mujahideen factions in Afghanistan have turned the city of Kabul into a battleground, and they are busily employed bombing neighborhoods, looting, maiming, and raping each other's followers in the name of Islam. A growing religious movement in Pakistan—the *Anjuman Sipah-e-Sahaba*—is seeking the expulsion of Shias from Islam, and they regularly commit assassinations and murders to achieve this end. Anger, violence, and fanaticism seem to have penetrated every Muslim country.

One consequence of Muslim extremism has been a growing (and reactionary) tendency in the West to view most, if not all, Muslims as fanatics maddened beyond reason. But this is irrational. Violence and extremism are not the monopoly of Islamic fundamentalism; they are common to fundamentalism of every faith. Moreover, in quantitative terms, the suffering inflicted on humanity by modern Western civilizations has been far greater, largely because they have wielded far greater powers of destruction. Nevertheless, political Islam has an extraordinary power to mobilize Muslims the world over. Why is it so militantly anti-West in character?

Beyond faith

The answers, I believe, have relatively little to do with matters of faith and much more to do with the tangible, direct experiences of Muslims in this century. Militant political Islam has emerged as a response to the abject failure of Muslim society to provide the essentials needed for dignified human existence. Grossly unequal distribution of wealth in Muslim countries, suppression of fundamental human liberties, mistreatment of minorities and women, and populations soaring out of control, have produced a nightmare. Muslim states have massacred their own citizens by the thousands in Iraq, Syria, Iran, former East Pakistan, and Timor. There are dictators and coups, nepotism and corruption. Heads of government in Muslim countries rarely retire to play golf; instead, they often meet violent death through assassination.

Plagued by religious and ethnic hatreds, and pushed backward by reactionary internal forces, the crisis of Muslim society has never been deeper. Eqbal Ahmed, writing in a Pakistani daily, observes: "It is difficult to recall a more demoralized and corrupt community in the annals of history. Each of the 30-odd 'Islamic' governments are dominated by self-serving rulers. . . . All are addicted to armaments and to dependence on suppliers. All are littered with machines but command no technology. Not one is home to a university or research center of repute. They lack the will no less than the know-how to transform wealth into capital, importance into influence, resource into power."

Responding to crisis

Faced with a fundamental crisis and manifest decline, three distinct responses have emerged within Islamic civilization in this century. The first, and the most visible, seeks to assign all failures and defeats to a deviation from the True Path; it seeks to restore some idealized version of the glorious Muslim past through a return to strict adherence to Islam and its rituals. Saudi Arabia and Iran—otherwise bitter ideological enemies—are united in their opposition to modernism in values and the secular, rationalist, and universalist ideal.

The second response, still dominant although muted, is to reinterpret the Islamic faith to accommodate modern thought. This has led to a third variant rooted in pragmatism, in which the requirements of religion and faith are considered as essentially unrelated to the direct concerns of economic and political life. But even Muslim rulers subscribing to this point of view (Mohammed Ali Jinnah, Habib Borguiba, Gamel Abdul Nasser, Ali Bhutto, and Saddam Hussein are examples), have freely used Islamic symbolism to attain political or national goals and have thereby further legitimized the use of Islam in politics.

Internal crisis, while explaining the rise of fundamentalist Islamic movements, does not by itself explain why such movements have such a strong anti-Western orientation. A glance at history, however, explains the anti-Western bias.

Over the centuries, both Islam's relationship with the West as well as its territorial boundaries have fluctuated. There were times of bitter strife as, for instance, during the Crusades, but there were also times of intimate and fruitful collaboration. Seven centuries of Muslim rule in Spain gave the Europeans, among other things, access to the accumulated treasures of Greek and Islamic learning. There was a fundamental symmetry between Islam and the West, a symmetry broken by the rapid rise of science in the West, followed by a European imperialism equipped, both militarily and intellectually, with powerful products of the Age of Reason. The relationship was never to be the same again.

In spite of a five-centuries-long tradition of brilliant scholarship and scientific achievement, Islamic civilization has been static since around the fourteenth century. Thus, traditional Muslim society stood defenseless before the onslaught of eighteenth century mercantile imperialism. Almost all of the Muslim world, ranging from West Africa to East Asia, was rapidly colonized. In central Asia, following the reign of Peter the Great and Russia's emergence as a great power in the 1800s, the Khanates of Khiva, Bukhara, and Kokand were quick prizes for colonial acquisition. The confrontation of an industrial and capitalist West with a traditional and pre-capitalist society left the latter numbed, disoriented, and humiliated. The scars have yet to heal.

The end of the colonial era brought euphoria, probably much like the euphoria we see today in the Central Asian Muslim republics. But with traditional political, economic, social, and cultural relationships badly eroded in the long encounter with imperialism, the emerging Muslim states were poorly equipped to deal with a world that had changed so much. Nationalist movements soon foundered, or, as in Ahmed Sukarno's Indonesia and Mohammed Mossadeq's Iran, became victims of U.S.-sponsored subversion.

But beyond doubt, the forcible dispossession of the Palestinians from their homeland created the greatest Muslim hostility to the West. Israeli policy, aimed at eliminating the Palestinians from the remnants of their homeland, is seen as having been consistently supported by the United States. Once a largely secular and nationalist Arab cause, the Palestinian issue ranks as the single most prominent Islamic issue.

In the latter part of this century, a dangerous and vicious pattern was established in the Muslim relationship with the West. Muslims see themselves as bullied by Western military might; this leads to a general perception that the West is dominating and subverting Muslim societies through economic and cultural power. Therefore the Muslims, as would any other people who feel besieged, tend to fall back and reinforce their own identity through opposition to the West and through appeals to past Islamic glories.

A consequence of the Muslim siege mentality—a trait they share with Israelis—has been mass paranoia. Wild theories of international conspiracies against Islam are believed by astonishingly large numbers of Muslims. Preachers and politicians denounce the West as the cause of all the ills of the Islamic world. Western culture, which invades every Muslim home via the mass media, is roundly condemned although it is allowed to continue, and is sometimes even welcomed, producing a curious form of cultural schizophrenia.

Irreligious bombs

If the drive for nuclear arms is not derived from religion, a more general question remains. Why do some nation-states seek nuclear weapons? Perceptions of threats are undoubtedly important, but they are not necessarily the sole motivation. Prestige and power may be extremely important as well. Given the perverse set of values that mankind has inherited from its violent past, a nation with the power of annihilation is presumably more important than one without it. The United Nations appears to accept this implicitly; all five permanent members of the Security Council are nuclear weapons powers.

In a global climate of hostility, antagonism, and internecine wars, massive supplies of conventional but highly destructive arms from the industrial North are avidly sought by many countries of the South. The Gulf War reinforced this message; it was an important stimulus for the proliferation of all types of weapons. A few months after the war, one of the most successful exhibitions of military aircraft—in terms of numbers of buyers from developing countries—was held at Le Bourget, north of Paris. Patriot missiles, F-16s, helicopter gunships, and smart missiles are in great demand. Nuclear weapons—providing "more bang for the buck"—would be even more attractive if they were available.

In a sense, nuclear weapons are a sequel to modernization. The Indian case is perhaps the clearest recent demonstration of the phenomena. Nuclear weapons, with their surrounding mystique and awesome power to destroy, are shimmering objects symbolizing the mastery of advanced technology. National chauvinism finds a rallying point: build the bomb!

Islam or no Islam, many Muslim countries want nuclear weapons for specific national reasons. Following the logic of modernization, they—as well as other developing countries—are imitating what the developed North has already done. Thus, Muslim states are indistinguishable from other modernizing states that have, or aspire to have, weapons of mass destruction. If a Muslim state acquires a nuclear arsenal, it is very likely to behave as would any other nuclear state. Islamic unity would probably have no real significance.

Bombs made easy

Can international controls effectively limit the spread of nuclear weapons? Having greatly extended its influence in the Security Council after the disintegration of the Soviet Union, the United States clearly hopes to use the United Nations as a means to this end. Other means include the International Atomic Energy Agency (IAEA) and the Nuclear Suppliers Group. New monitoring procedures will be implemented to check that countries that have signed the Nuclear Non-Proliferation Treaty (NPT) comply with treaty rules. In April 1992, the London Suppliers Group extended controls to dual-use goods. The group resolved that such goods would not be sold to states suspected of having nuclear explosives programs. But the effectiveness of such restrictions is questionable. Dual-use items include computers, control systems, high-speed cameras, hardened steels, and cryotrons, to name a few. All have industrial as well as potential nuclear uses. Careful export controls and new monitoring methods may limit the rate of proliferation, but it is obvious that these procedures are effective only to a point.

It is becoming easier and easier for even rather poor countries with marginal technological infrastructures to develop the rudiments of a nuclear weapons program—provided that they are sufficiently motivated to do so. Pakistan has proved this point. It has a per capita GNP of less than $400, about 74 percent of its people are illiterate, and the quality of its educational system ranks close to the poor-

"I thought we agreed not to make any major purchases for a while."

est in the world. The university system has essentially collapsed over the last two decades. The industrial base is narrow—80 percent of its exports are agriculturally based, and the manufacturing sector accounts for only 20 percent of its gross domestic product.

In spite of these disadvantages, Pakistan is the first Muslim state to possess nuclear weapons. Following the Indian nuclear explosion of 1974, Pakistan felt it was in mortal danger from a country with which it had fought three major wars. Developing nuclear weapons was viewed as an issue of survival; the prestige and leverage this brought in the Arab world were welcome but secondary rewards. By concentrating its limited scientific energies into the nuclear program, and by developing a superb international network for the clandestine purchase of nuclear materials, Pakistan has been able to create a fairly sophisticated nuclear establishment relative to its other areas of scientific endeavor. According to a Carnegie Endowment For International Peace report, Pakistan obtained its first atomic weapon in 1986. It currently has fissile material for probably 10 to 15 easily assembled A-bombs, and possibly all the components for them.

Pakistan's current level of nuclear development does not qualify it as a nuclear power. Covert possession of a few crude bombs of uncertain reliability and explosive yield does not equal real military significance. Other key requirements—delivery mechanisms, and the command, control, communications, and information systems needed to conduct nuclear war—are not yet in place. If India declared itself nuclear, Pakistan would presumably do the same. Pakistan is playing a game of careful ambiguity, closely watching India's moves.

If Pakistan can do it, so can many other countries. Among Muslim countries, Iraq and Iran are the most likely to follow suit. Their financial resources are far greater than Pakistan's and their technical manpower base is at a roughly comparable level. According to nuclear weapons experts who examined the evidence compiled by the U.N. Special Commission on Iraq at the time of the Gulf War, Iraq was about three years away from producing its first atomic weapon. The destruction of its nuclear facilities, both during and after the war, has been a major setback to its efforts. But even so, the possibility exists that once sanctions are lifted, Iraq will be able to rebuild its program in a few years.

Relative to Iraq, Iran is better placed, should it seriously seek to develop nuclear capabilities. At the time of the Shah, as part of a grandiose program to install tens of reactors for nuclear power generation, thousands of Iranian scientists, engineers, and technicians were sent to the United States and other Western countries for training. After the revolution, the program was scrapped, but the manpower still exists in Iran to some degree, and a revival of interest is apparent from the September 1992 deal Iran made with China for the purchase of a test reactor.

Searching for solutions

Nuclear weapons states must take effective steps toward global denuclearization. There is no other way. While the NPT is important as a means to decrease the chances of nuclear conflict, and should be signed by all nations, it must be regarded as only an interim arrangement. There is absolutely no reason why the world should—or will—accept that only those states that currently possess nuclear weapons have the right to possess them indefinitely. Nuclear-weapons states could demonstrate their commitment to eventual global denuclearization—and endow their anti-proliferation efforts with moral authority—by reducing weapon inventories. The strategic arms reduction and intermediate-range nuclear forces treaties are positive steps, but they do not go far enough. Even if both treaties are fully implemented, the United States will still be left with 3,500 strategic weapons. A minimal deterrent needs a few dozen weapons at most.

They should also stop asserting that they need to "modernize" their weapons, even if the total size of their arsenals is fixed. As a corollary, nuclear weapons testing ought to be completely banned.

They should firmly declare a "no-first-use" policy and renounce the threat of nuclear weapons in the conduct of international affairs. They must provide guarantees that under no circumstances will nuclear weapons be used against non-nuclear states. The United States, for example, had actively contemplated using these weapons in the course of the Korean and Vietnam wars against non-nuclear opponents.

They must also provide a guarantee that, if a non-nuclear weapons state is attacked or threatened with attack with nuclear weapons, then a nuclear cover will be provided to that state.

They must penalize proliferators impartially. Pakistan, Iran, and Iraq cannot be treated differently than Israel. Such a stand is morally indefensible. It would be a supreme irony if the United States were to recruit Israel—a clandestine nuclear weapon state—to enforce non-proliferation.

Logically, the United Nations is the organization to lay the foundations for a new nuclear order. One possibility is reviving the Baruch Plan, which was rejected by the Soviet Union in 1946. This plan required that all nuclear materials and explosives be owned by a central authority under direct control of the Security Council, which would have custody of a few nuclear weapons to deter secret possession of nuclear weapons by any other state. No individual state could own or possess nuclear weapons. Nearly 50 years ago the plan was given short shrift. Now it merits serious discussion.

Bridging the gulf

But while it is up to the nuclear-weapons states to take the first meaningful steps, even their total and unilateral renunciation of nuclear weapons would not be enough to prevent other nations from acquiring them. There is a deeper problem here, a problem whose roots lie in the division of the world into North and South.

A deep gulf divides the two hemispheres, the empowered and the disempowered, the haves and the have-nots. Instant global communication makes it impossible to hide poverty—whether it be poverty of wealth, of power, or of organizational capability. As this gulf widens, each side feels that it has less and less in common with the other. Antagonisms, frustrations, and resentments build up and find expression through reasserted religious, national, linguistic, and tribal identities. Islam, in particular, is well-adapted to nurture movements deriving their strength from such identities, although the current state of Eastern Europe is testimony that this resurgence is far more general.

It is highly unlikely that an Islamic bomb will ever exist. It is improbable, but not impossible; it could conceivably come into existence if Muslims feel their backs are to the wall. Islam could provide a sufficiently strong legitimizing principle if the whole Muslim nation perceives itself as under attack. There is a suspicion among Muslims that, like the Jews of the 1940s, they are becoming targets for ethnic cleansing. The genocide in Bosnia, the mass expulsion of Palestinians demanded by right-wing parties in Israel, and the collective punishment inflicted on Iraqi civilians are widely perceived to be just such ethnic cleansing. The same suspicions may underpin the search for Muslim power.

The West must not feed the Muslim psychosis. A political, not punitive, approach is needed—one that emphasizes positive diplomacy and the need for regional arrangements. Muslim countries need to be empowered, to regain hope for the future, and to have recourse to justice in their disputes with other nations. This demands a new global democracy which gives them and other nations of the South real political and economic power. The skewed structure of two major international institutions, the Security Council and the International Monetary Fund, needs to be straightened and made representative of the entities each represents.

At the same time, democratic movements for peaceful social change in countries of the South need to be strengthened. No proliferator, and in particular, no Muslim country among them, provides its citizens an existence in which human dignity and liberty are respected. Addiction to armaments, callous and brutal elites, islands of splendor amid vast seas of poverty and human misery, widespread corruption and nepotism, and grandiose prestige projects are all too common. These countries, lacking internal dynamism and the strength to confront internal weaknesses, resort to conspiratorial arguments. The South's claim to a higher degree of morality and spirituality is a sham; the treatment of its own citizens testifies to that.

The task of limiting proliferation is a daunting one, and the outcome is uncertain. It is true that the end of the U.S.-Soviet confrontation has created a dramatic new possibility for a world with far fewer nuclear weapons. But this historic opportunity could easily be lost and supplanted by nuclear anarchy, a likely consequence of rapidly spreading, widely available, multi-purpose technologies along with an emerging global scientific culture. Paradoxically, though the chance of many nuclear detonations has shrunk essentially to zero, the chance of a single or few detonations is likely to grow. This is no time for complacency. ■

IF NUKES ARE OUTLAWED, ONLY OUTLAWS WILL HAVE NUKES.

Exposing Americans

American Ground Zero
by Carole Gallagher
The MIT Press, 1993
464 pages; $50.00
($39.95 until September 1)

IRIS POLISKI

Carole Gallagher is a professional photographer whose work includes photographs of people downwind from the nuclear test site in Kazakhstan, formerly part of the Soviet Union. *American Ground Zero* is a collection of startling photographs of the people in the western United States who were affected by the radioactive fallout from atomic blasts at the Nevada test site from 1951 to 1963.

Six states—Utah, Arizona, Wyoming, North Dakota, South Dakota, and New Mexico—were most directly downwind from the nuclear tests. The greatest concentration of deadly dust fell on Utah, where people, animals, and land suffered the most. The experiences relayed by the people who Gallagher photographed testify to the Atomic Energy Commission's (AEC) disregard for the lives of U.S. citizens and for the consequences of its actions. It is a population with high levels of cancer, leukemia, and other types of radiation sickness and mutation.

In a declassified "top secret" memo, the AEC described the "downwinders" as "a low-use segment of the population." The agency characterized the enormous areas of the southwest that lay in the fallout path as "virtually uninhabited"—dismissing farms and American Indian communities alike. The Energy Depart-

Ken Case (above), a test site worker, regularly drove cattle over "Ground Zero" after atomic bomb detonations. "They got cancer and we got cancer," he says of this AEC experimental program. Left, Herman Hogan's hands show effects of his bone marrow cancer. A test site worker, he frequently dipped his arms into radioactive waste water.

PHOTOS BY CAROLE GALLAGHER, *AMERICAN GROUND ZERO* ment, inheritor of much of the AEC's nuclear responsibility, still seems uninterested in compensating surviving victims, some of whom are military veterans and test site workers.

Utah's population is primarily Mormon. Gallagher believes that the Mormon culture made many of the people who speak from the pages of *American Ground Zero* perfect victims. Brought up to believe that they, their church, and their government were specially created by a higher power, they could not—and in some cases, would not—believe that their government could possibly have been party to such bad things.

Their own bishops, legislators, and sometimes their doctors denied any link between their mysterious diseases and deaths and the radioactive fallout that covered animals, crops, homes, food, and skin. There were a few whistleblowers; the AEC threatened them with jail, the church with excommunication. The Mormon hierarchy remains officially silent on the testing issue.

Echoes of "believe-what-we're-told" attitudes are not lost on Gallagher, who asks whether we have mutated into a "numbed nation of 'good Germans,' unwilling to see." Energy and Defense Department personnel should be required to read *American Ground Zero* aloud to their families. ■

Iris Poliski is the senior editor of the Bulletin.

Thinking in the bathtub

Genius in the Shadows
by William Lanouette with
Bela Silard
Charles Scribner's Sons, 1993
587 pages; $35.00

REBECCA LOWEN

Genius in the Shadows is a well researched, anecdote-rich biography of Leo Szilard, the inventive Hungarian physicist who pressed Einstein in 1939 to alert President Roosevelt to the possible wartime uses of atomic energy. Withdrawing from nuclear physics after the bombing of Hiroshima, Szilard studied biology, advocated international arms control, and wrote, among other things, *The Voice of the Dolphins*, a utopian novel offering his ideas for reducing Cold War tensions. Based on research in the Leo Szilard papers, on extensive interviews with Szilard's colleagues and friends, and on material and recollections provided by Szilard's younger brother, Bela Silard, the book offers a detailed picture of the puckish physicist. William Lanouette, an energy policy analyst in the U.S. General Accounting Office, clearly views Szilard as a kind of antihero of the atomic age.

Parts of Szilard's story have been told before, most recently by Richard Rhodes who begins *The Making of the Atomic Bomb* with Szilard's conception of the nuclear chain reaction in 1933 and concludes with Szilard's effort to prevent the use of the bomb against Japan and his decision to study biology. Lanouette ably covers this ground in the middle third of the book, adding evidence that Szilard did not voluntarily abandon nuclear physics after 1945. In fact, he attempted to work on developing "peaceful" aspects of the atom at Argonne National Laboratory. Szilard was denied a position there, however, through the influence of Gen. Leslie Groves, director of the U.S. atomic bomb project, who disliked and deeply distrusted the physicist who had engaged in the "baiting of brass hats" while working on the bomb project.

The first—and best—third of *Genius in the Shadows* presents Szilard's early years. Lanouette begins with Szilard's comfortable childhood (he was the clever, if bossy, eldest child of indulgent middle-class Hungarian Jews). The author then tells of Szilard's indifferent service as a soldier in World War I (he caught the flu and never saw combat), and his enthusiasm as a young engineering student for the postwar socialist regime of Bela Kun. The fall of Kun and the backlash against Jews and socialists pushed Szilard to leave Hungary for Berlin. Here he studied with some of the luminaries of modern physics, including Einstein, with whom he took out several patents on a refrigerator pump.

Lanouette paints Szilard's postgraduate years in Germany as filled

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with uncertainty and punctuated by moments of self doubt. Szilard failed to find regular employment, worried about his limitations as a physicist who lacked the patience and dexterity for experimental work and the mathematical abilities of the best theorists, and offended many of his scientific peers with his resolute frankness and his interest in patents. (Szilard's friend, fellow Hungarian physicist Eugene Wigner, admitted that the young Szilard could be "an ass.")

Unfortunately, Lanouette does not speculate on the significance of Szilard's somewhat anomalous position on the fringes of the academic community. Does it help explain why Szilard was unwilling to draw clear distinctions between the realms of science and politics, unlike so many of his contemporaries who sought in their professional community a refuge from external concerns as well as a context for claims to disinterested expertise? While Lanouette should not be expected to provide definitive answers to such questions, he might have felt freer to interpret and analyze the significance of the particular incidents and details he relates.

The final section of *Genius in the Shadows* covers Szilard's more politically active life after 1945. In these years he helped defeat legislation giving the military control over nuclear research, met privately with Khrushchev to offer ideas for improving U.S.-Soviet relations, and established the Council for a Livable World.

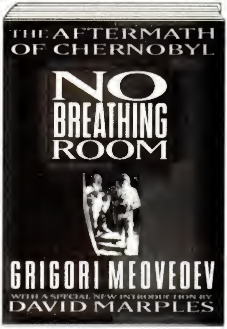
Given Lanouette's long-standing interest in arms control, this last section is the least satisfying. Lanouette clearly admires Szilard for battling the arms race and opposing the Cold War. Although this does not blind him to certain unattractive aspects of Szilard's character (such as dismayingly insensitive behavior toward his wife, Trude Weiss), it does constrain him from adequately analyzing Szilard's political tactics and his ideas for arms control and political reform.

While Szilard may be esteemed for dissenting from the dominant view of his time, his dissent was of a limited nature, circumscribed by a generally elitist, technocratic political orientation which prevented him from committing to sustained and organized political activity. Rather than heralding the Szilard–Khrushchev meeting as the beginning of a tradition of citizen diplomacy (it was, in fact, neither a new nor uncontroversial tactic), Lanouette might have seen it as reflecting Szilard's tendency to overestimate his own ability to influence the course of historical events. This tendency stemmed from Szilard's tremendous faith in the powers of the select few, possessed of the best scientific minds, to solve the world's problems. In this respect Szilard was not very different from many of the opponents of disarmament, including the better known Hungarian, Edward Teller.

After a decade in which Teller's reputation and influence extended to the highest levels of the U.S. government, Lanouette's interest in recapturing an alternative voice is praiseworthy however much one wishes he had achieved more critical distance from his subject. *Genius in the Shadows* provides an invaluable record of Szilard's life before 1939 and a thorough, readable account of a significant historical figure. ■

Rebecca Lowen is a Guggenheim fellow at the Smithsonian Institution's National Air and Space Museum where she is completing Creating the Cold War University *(forthcoming).*

"As compelling as it is chilling..."*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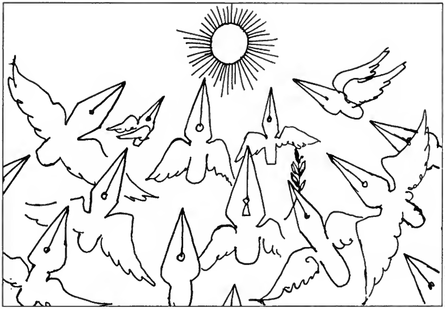
Post–*Nuclear Times*

Between Fear & Hope:
A Decade of Peace Activism Compiled from *Nuclear Times* Magazine 1982 to Present
edited by Sonia Shah
Fortkamp Publishing, 1992
293 pages; $17.95

STEVE BREYMAN

Audio buffs have a magazine, horse fanciers have a magazine, snowmobilers have a magazine, and anti-nuclear weapons activists had a magazine. No ordinary hobbyist magazine, *Nuclear Times*, which died last year, was devoted to education between and communication among peace activists.



PAUL VALERRY

Between Fear & Hope testifies to the diligence and commitment of *Nuclear Times*'s contributors and readers in their struggle against war and militarism. During the early 1980s, citizens from all walks of life organized a social movement designed to change people's attitudes and values, transform institutions and culture, and reform the relationship between people and their government.

It's a sign of the waning nuclear times that the U.S. peace movement can sustain neither its red-hot mobilization nor its magazine—declines that are tied to the peace movement's success. But *Between Fear & Hope* is useful. It charts the movement's identity, actions, and ideas. Whether one is interested in the peace movement's growth and development, its representation by the media, its hawking of alternative security concepts, or its internal debates over strategy, it's all here. Sonia Shah, *Nuclear Times*'s last managing editor, has compiled articles from many of the best known leaders and chroniclers of the movement, including Randy Kehler, David Cortright, Pam Solo, and Daniel Ellsberg. Written by activists and scholars for activists and scholars, the book helps the peace movement understand its past and prepare for its future.

Effective social movements must, according to *Between Fear & Hope*, identify and understand the problems they seek to change and the forces underlying them; educate the public and build coalitions; use public concern as a lever to move the powers-that-be; and construct sustainable organizations to coordinate these activities.

Almost 20 years ago, sociologist William Gamson wrote that social movements achieve success by gaining acceptance from their antagonists and winning new benefits for their constituents. The U.S. peace movement did both. It came to be seen by the media, Congress, and even the Reagan administration as a legitimate voice of the popular yearning for peace, disarmament, and reordered national priorities. The contributors to *Between Fear & Hope* make it clear that the peace movement can take credit for progress on many fronts: blunting the power of the military-industrial complex; getting the United States to the bargaining table in Geneva; educating a wide swath of the public on the dangers of nuclear war; advertising alternative security proposals; supporting the Intermediate-range Nuclear Forces Treaty; and hastening the decline of the Cold War.

At the same time, numerous contributors admit, the peace movement achieved only a portion of its goals. It failed to undermine the policy of nuclear deterrence, to freeze nuclear testing and weapons deployment, and to form strong alliances with those battling U.S. intervention in Central America. To paraphrase Pam Solo, it was unable to fully move from protesting policy to making policy.

While immersed in the 1980s struggle for arms control, the peace movement—most notably the Freeze movement—proved incapable of simultaneously making the case against arms transfers, the Rapid Deployment Force (now called Central Command), and the legitimacy of superpower intervention. It also had difficulty making a positive case for conservation, renewable energy, a resolution of the Arab-Israeli conflict, and economic sanctions rather than war in the Gulf. Confronting the roots of war, say many of the contributors, is now the central focus of peace activism.

Today the most comprehensive attempt to construct a world without war comes from efforts to redefine security and replace traditional notions with conceptions of alternative or common security. Activists know that only the creation of a global system of common security will directly address the causes of war. An entire chapter of *Between Fear & Hope* is devoted to detailed thinking about the system, which would include international arbitration and nonviolent conflict resolution; a coordinating role for the United Nations and regional organizations; respect for international law and human rights; democracy and ecological integrity; sustainable development; the satisfaction of basic human needs; and preventive diplomacy.

The contributors agree that only within such an overarching framework, one that recognizes the connections and feedbacks among problems, can real security be achieved. This is perhaps the main strength of the book, and the primary accomplishment of the peace movement: the development and marketing of conceptions that highlight the self-defeating character of unilateral security provisions.

The book is good for those who missed the articles the first time around, and for faithful readers of *Nuclear Times*. It is very useful for students of social movement strategy and communication, and it is a handy, accessible resource for organizers working for common security. *Between Fear & Hope* advances our knowledge of one of the largest and most important social movements in recent U.S. history. ■

Steve Breyman, a visiting assistant professor at Marquette University in Milwaukee, is author of Spears Into Pruning Hooks: The 1980s West German Peace Movement *(forthcoming).*

Smart Kills

War in the Age of Intelligent Machines
by Manuel De Landa
MIT Press, 1992
271 pages; $16.95

JOHN BELL

Weapons programmed to kill without reference to human authority are usually considered machines of science fiction and nightmares. Manuel De Landa, a computer programmer, wants us to believe that killer automata are becoming a reality—the inevitable result of military equipment's centuries-long evolution.

He points out that the U.S. military is already developing pilotless aircraft and unmanned tanks capable of selecting and destroying their own targets. He warns that "even if artificial intelligence is not at present sufficiently sophisticated to create true 'killer robots,' when synthetic intelligence *does* make its appearance on the planet, there will already be a predatory role awaiting it."

The Gulf War displayed an array of sophisticated Western weaponry to the world that, De Landa argues, represents both a glimpse of killing machines to come and a profound shift in how people relate to both machines and information. He tackles the nature of this shift by first amassing an erudite, eclectic mass of historical and technological evidence. Although this is a fascinating review of the history of warfare and the development of computer systems, *War in the Age of Intelligent Machines* is a philosophical rather than factual book. De Landa discusses the evidence in terms of chaos theory and the concept of a "machinic phylum." This new phylum appears when a "group of previously disconnected elements suddenly reaches a critical point at which they begin to 'co-operate' to form a higher level entity." Or, put simply, when the whole is greater than the parts.

De Landa first looks at how the internal workings of the war machine have evolved since the sixteenth century in response to new technologies. The bullet and the breech-loading rifle forced army commanders to revolutionize their military tactics, and computers are similarly changing modern warfare. According to De Landa, both of these examples illustrate the machinic phylum's effect on the military mind.

The second chapter examines these matters from the other side—how the military mind has influenced the development of the machinic phylum and information processing—by setting out the military's role in the development of computing. His account of software and hardware is as informative as his first chapter but not as interesting—perhaps because the story of computers is better known and shorter than the history of warfare. Both chapters are great fun and informative (if a little heavy) for anyone interested in the history of technology. There can't be too many other writers who can trace the military influence on the canned food industry (Napoleon), the development of siege cities, and modern war-gamers' unwillingness to press an allegorically nuclear button. These are just some of the ideas military commanders have absorbed as they have become less and less connected to the killing on the battlefield. Technology has aided this disassociation: clubs gave way to arrows, which in turn became useless against bullets. Now computers have accelerated the process of physically and emotionally separating soldiers from their enemies.

The third chapter looks at how the military puts information to work—spying and gathering data on other countries and their armed forces. De Landa argues that the complexity of information technology and the amount of data it gathers pose management problems for the military that are further examples of the machinic phylum at work. Just as bullets and breech-loading guns forced opposing armies to fight from dispersed positions, so the imminent arrival of artificial intelligence in a predatory role is forcing the military to rethink its strategies and tactics. The danger, says De Landa, is that this time the commanders will be so overwhelmed by the mass of data coming from the battlefield that they will be forced to let killer automata act without human intervention.

De Landa's topic is certainly timely. Unfortunately, his analysis does not go much beyond the old argument that artificial intelligence (if such a thing ever comes into existence) may not be entirely a good thing. While he does deliver new and sound evidence to support common arguments about financial and political control over the military, he fails to explain how to "bell" the killer automaton. ■

John Bell, editor of Opto & Laser Europe, *published by the United Kingdom's Institute of Physics Publishing, was technology editor of* New Scientist.

Book note

From Eros to Gaia
by Freeman Dyson
Pantheon Books, 1992
371 pages; $25.00

Freeman Dyson is a physicist with interests far beyond the purely scientific. He explains that the title *From Eros to Gaia* defines the beginning and the end, and that is an analogy for the range of these collected writings, from 1933 to 1990. (A very youthful effort is included.)

There is much here for fans of science and the oddities of humankind under sections labeled Stories, Things, Institutions, Politics, and Books. Many of Dyson's observations on the nature of committees, missed scientific opportunities, the advantages of small science, and a fascinating account of Richard Feynman's experience with a boa constrictor, are trenchant and frequently funny. He describes Wernher von Braun's proposed Mars project (circa 1952) as based on the Berlin airlift. Space shuttles flying four missions every day for eight months seemed perfectly logical. Only the experience of the modern space shuttle tilts the earlier theory toward science fiction.

Dyson is no space romantic. He judges the Apollo program as a successful sporting event, but a great missed opportunity for science. (His criticism is seconded by an observation in a recent *Spectator* magazine article: "Man on the moon. No jobs there, but no one noticed.") And Dyson is crisp on the Apollo program's inefficient use of resources.

He is delighted with the discoveries made by unprepossessing astronomers and other scientists, frequently using relatively simple equipment. Science, says the author, need not necessarily be small to be successful. It does, however, need to be different. And then he tells us about Bernhard Schmidt, who invented and built glorious telescopes—with one hand, as his other had been destroyed in an explosion.

Dyson knows scientists—living and dead—and he has a knack for spotting their truly arresting observations. From J. B. S. Haldane's essay "On Being the Right Size," for instance, he offers us this: "You can drop a mouse down a thousand-yard mine shaft; on arriving at the bottom, it gets a slight shock and walks away. A rat is killed, a man is broken, a horse splashes." And the book's sections are marked with some of scientist Leo Szilard's ten commandments; one of the best: "Do not destroy what you cannot create." ■

LIES *(cont. from p. 13)*

requires reloading 2,000 assemblies yearly for each of the fleets.) The depots are in disrepair and do not meet international standards. Many purification systems are missing. And solid radioactive wastes are not being transferred to Ministry of Atomic Energy plants.

The Soviet government's 1985 plan to build waste depositories for nuclear compartments from submarines by 1993 was never realized. Today, radioactive materials at fleet bases are simply stored on open ground. The Yablokov commission predicted that Russia will be forced to continue dumping radioactive waste of all kinds into the oceans for the next five years, since the construction of new coastal complexes for processing liquid radioactive waste is not expected to start until 1997. The program's cost in today's prices is estimated at one billion rubles. Treating solid radioactive wastes will be even more expensive. No decisions have been made on how to address the problem. ■

Sergei Leskov, who covers science and economic issues for Izvestia *in Moscow, is a* Bulletin *visiting fellow.*

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Powering down quietly

With little fanfare, the U.S. Navy has begun scuttling much of its nuclear-powered fleet. More than 50 nuclear submarines have been scrapped to date—half since 1990—and at least 43 more are scheduled for retirement before 1998. The first nuclear-powered surface ships are also being retired, with five of nine nuclear cruisers to be decommissioned before 1995.

With most smaller classes of nuclear attack submarines virtually gone, the navy will now begin the process of retiring all 32 Sturgeon-class attack submarines over the next seven years. The first eight will be decommissioned in fiscal year 1994. The newest Los Angeles-class attack submarines are also on the chopping block. The U.S.S. *Baton Rouge*, which collided with a Russian Sierra-class submarine in the Barents Sea in February 1992, will be decommissioned in 1994, and the navy plans to retire the first nine Los Angeles-class submarines rather than refuel them. The navy program will leave 40 attack subs in the fleet by early in the next century.

Nuclear-powered ballistic missile submarines (SSBNs) are also being trimmed. All Poseidon-types are on their way out, and another dozen armed with Trident I missiles are being retired. The first six will leave the fleet in 1994. Even some Ohio-class SSBNs are earmarked for retirement. The previous plan was to retain all 18 Ohio-class submarines until the end of the century. The navy is studying a fleet size of only 12—half the 24 envisioned by the Reagan administration. The U.S.S. *Ohio*'s overhaul has already been delayed to save money, and the boat could be retired instead of refueled.

Meanwhile, the navy is quietly moving toward decommissioning its entire fleet of nuclear-powered cruisers, despite having recently told Congress that these ships "are of increased value in an era of fewer forward-deployed ships and bases." Older, one-of-a-kind classes, like the U.S.S. *Truxton* and U.S.S. *Bainbridge*, built in the 1960s, were already slated for retirement before the Clinton administration took office. The Pacific fleet recently announced that the U.S.S. *Long Beach* would be decommissioned in 1994.

But newer ships are also being pensioned. One of these, the U.S.S. *Virginia*, has been in the fleet for only 18 years and was scheduled to begin a refueling overhaul in 1994. The other, the U.S.S. *Texas*, had begun a 23-month complex refueling overhaul at Puget Sound Naval Shipyard when the navy decided to scrap the ship instead.

Two California-class cruisers commissioned in 1974 and 1975, the U.S.S. *California* and the U.S.S. *South Carolina*, are also being refueled, and two other Virginia-class cruisers, the U.S.S. *Mississippi* and the the U.S.S. *Arkansas*, are scheduled to be refueled in 1996 and 1997. Their status is uncertain, and the navy may scrap these ships also.

Ironically, while nuclear submarines and cruisers are being cut and the need to cruise the sea on nuclear power is dwindling, Admiral Rickover's dream remains alive. The navy continues to reject the idea of building non-nuclear submarines, and two new Seawolf-class attack submarines are currently under construction. An entirely new nuclear attack submarine class—the Centurion—is being designed.

Moreover, the navy continues to move toward an all nuclear-powered aircraft carrier fleet. Older conventionally powered carriers are being retired, but the first nuclear carrier, the U.S.S. *Enterprise*, is being refueled at Newport News, Virginia. Two more Nimitz-class aircraft carriers are being built at the same yard, and the navy recently announced plans to build a tenth Nimitz carrier to be launched in 2007.

As the nuclear-powered fleet dwindles, the base structure that supports it also contracts. The list of planned base closures includes the Mare Island Naval Shipyard in California and the Charleston Naval Shipyard in South Carolina. Remaining nuclear work would be consolidated at Puget Sound, Washington, and Newport News, Virginia. Attack submarines homeported at New London, Connecticut, will be moved to other bases, and Electric Boat in Groton, Connecticut, formerly one of two nuclear construction yards, will close.

Have I got a deal for you

The British Ministry of Defense has put the Greenham Common air base in Berkshire up for sale. Greenham Common, 60 miles west of London, was the site of the longest running protest of U.S. nuclear weapons in Europe. After serving as a Royal Air Force base during World War II, Greenham Common was closed in 1946, but it reopened in 1951 as an advance base for the U.S. Strategic Air Command. It is not known exactly when U.S. nuclear weapons arrived, but it was probably in 1953, making Greenham Common one of the earliest nuclear weapon sites in Britain. After the runways were strengthened, in 1954 B-47s began to make periodic visits, and B-52s and B-58s came later. The base was handed back to the RAF in mid-1964, and its nuclear weapons were dispersed to other bases or returned to the United States.

On June 17, 1980, Greenham Common was identified as one of two British sites for U.S. ground-launched cruise missiles (GLCMs), and worldwide attention was focused on the spot when the first GLCMs arrived on November 14, 1983. Less than two weeks later, Pershing II missiles arrived in Germany, and the Soviets walked out of arms negotiations in Geneva to protest the introduction of these "Euromissiles."

Eventually there were 96 GLCMs deployed with the 501st Tactical Missile Wing. The Intermediate-range Nuclear Forces (INF) Treaty, which entered into force on June 1, 1988, required the destruction of the missiles, launchers, and associated equipment within three years. The last GLCMs were removed from Greenham Common in early March 1991 and were destroyed soon after. The cruise missile alert area must be excluded from the sale—under the INF Treaty it is subject to Russian inspection until 1999.

Nuclear Notebook is prepared by Robert S. Norris of the Natural Resources Defense Council and William M. Arkin of Greenpeace. Inquiries should be directed to NRDC, 1350 New York Avenue, N.W., Suite 300, Washington, D.C. 20005 (202-783-7800).

U.S. NUCLEAR WEAPONS STOCKPILE (JUNE 1993)

The U.S. nuclear stockpile is at its lowest level since late 1958 or early 1959. In the past year, many weapons were returned to central military storage depots in the United States and funneled to the Energy Department's Pantex facility for final disassembly and disposal. The table below shows the authors' estimate of the composition of the current operational stockpile, which contains some 10,500 warheads.

There are two other warhead categories: "inactive reserve," and warheads awaiting eventual disassembly. Only the W84, the warhead for ground-launched cruise missiles, is known to be in inactive reserve. The Intermediate-range Nuclear Forces (INF) Treaty banned its missiles and supporting equipment, but not the 400 warheads. Two other warheads—the W69, for the short-range attack missile; and the B53 nine-megaton bomb—may be in reserve as well.

Some 6,000 retired warheads are stored at Defense or Energy Department depots. Newly released information pinpoints the date some former warhead types were completely disassembled: (B28-0 and B28Y-1, September 1991; W33 8-inch artillery shell, September 1992; B43, April 1991; W50 Pershing 1a missile, April 1991; B57-1, September 1992; W70 Lance missile, September 1992; W71 Spartan anti-ballistic missile, September 1992; W79 8-inch artillery shell, September 1992; and W85 Pershing II missile, March 1991). Programs to modify the B61-2 and B61-5 to the B61-8 ended in February 1992. The disassembly of all W48 155-millimeter artillery projectiles was 60 percent complete when a pit cracked in mid-November, which halted further disassembly until the cause was discovered.

The operational stockpile will eventually drop to 5,100 warheads—3,500 strategic and 1,600 non-strategic weapons. The future stockpile will likely have six warhead types, with Los Alamos National Laboratory responsible for the design and support of the B61, W76, W80, and W88, and Lawrence Livermore National Laboratory responsible for the design and support of the W87 and B83.

For the first time in almost 40 years, the army has no nuclear weapons and the marines have no nuclear artillery. The marines are believed to have retained a non-strategic air-delivered capability (with the weapons in navy custody).

No new warheads have been produced since 1990, when the last pits produced at Rocky Flats were used at Pantex. In October 1992, the Energy Department established a dismantlement schedule of 2,000 warheads per year; it appears that it will meet that goal.

Low-level research efforts continue on new warhead programs. The Energy Department's 1994 budget request includes funds for research on a high-power radio frequency warhead, a precision low-yield warhead, a cruise missile-type warhead, and a generic design derived from the B61 bomb. The budget also includes research on new, more robust designs, and designs with advanced concepts for the use of nuclear materials.

Warhead/Weapon	*First produced*	*Yield (kilotons)*	*User*	*Number (warheads)*	*Status*
Bombs					
B53-1*	8/62	9,000	AF	50	Will be retired by mid-1990s.
B61 Strategic	10/66	10 to 500	AF	900	The Mod-7, the only version in the strategic stockpile, is a converted Mod-1 with Cat D PAL and IHE.
B61 Tactical	5/79	10 to 345	AF, N, NATO	1,525	Mods-3,-4,-10. The Mod-10 is a converted W85 Pershing II warhead. All have Cat F PALs and IHE.
B83/B83-1	6/83	low to 1,200	AF	650	Strategic bomb replaced B28, B43, B53.
Submarine-launched ballistic missiles					
W76/Trident I C4	6/78	100	N	3,125	Some 560 W76 warheads from retired Trident I SSBNs will be used to arm Atlantic Fleet Trident II SSBNs.
W88/Trident II D5	9/88	475	N	400	Warheads will supplement the W76 warhead and arm Atlantic Fleet Trident II SSBNs.
Intercontinental ballistic missiles					
W62/Minuteman III	3/70	170	AF	610	Warhead will be retired by late 1990s.
W78/Minuteman III	8/79	335	AF	920	Will be retired after W87 is retrofitted on Minuteman IIIs.
W87-0/MX	4/86	300	AF	525	Missile could be retired and W87 used for a single-warhead Minuteman III if START II is implemented.
Air-launched cruise missiles					
W80-1/ALCM	12/81	5 to 150	AF	1,200	Some 100 were converted to conventional versions and had their nuclear warheads removed; 35 were launched during the Gulf War. W80s are used to arm ACMs.
W80-1/ACM	?/90	5 to 150	AF	300	Operational in 1991. Original program of 1,461 ACMs has been cut to 460. Uses W80 from ALCMs.
W69/SRAM A*	10/71	170	AF	1,000	Missiles no longer on bombers; serious safety problems.
Sea-launched cruise missiles					
W80-0/SLCM	12/83	5 to 150	N	350	Nuclear SLCMs now stored ashore. Original program of 758 for 200 ships reduced to 367 for 184 vessels.

*May be in "inactive reserve"; not counted as part of active stockpile. **AF:** Air Force; **N:** Navy; **NATO:** non-U.S. delivery systems. **ACM—**advanced air-launched cruise missile; **ALCM—**air-launched cruise missile; **IHE—**insensitive high explosive; **PAL—**permissive action link. **SRAM—**short-range attack missile; **SSBN—**nuclear-powered ballistic missile submarine. In weapons nomenclature B stands for "bomb" and W for "warhead." The number following the letter indicates the order in which it was introduced into the stockpile; for example, W88 followed W87.

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